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Age Hardening Lead-Calcium Alloys
EARLE E. SCHUMACHER and GEORGE BOUTON

Alloys for Cable Sheathing
R. S. DEAN and J. E. RYJORD

Research Precision vs. Pedigree Steel
G. M. EATON

The Flow of Metals in Molds
Part II
GEORGE M. ENOS

Type Metals in Newspaper Industry
JOHN HELFRICH

●

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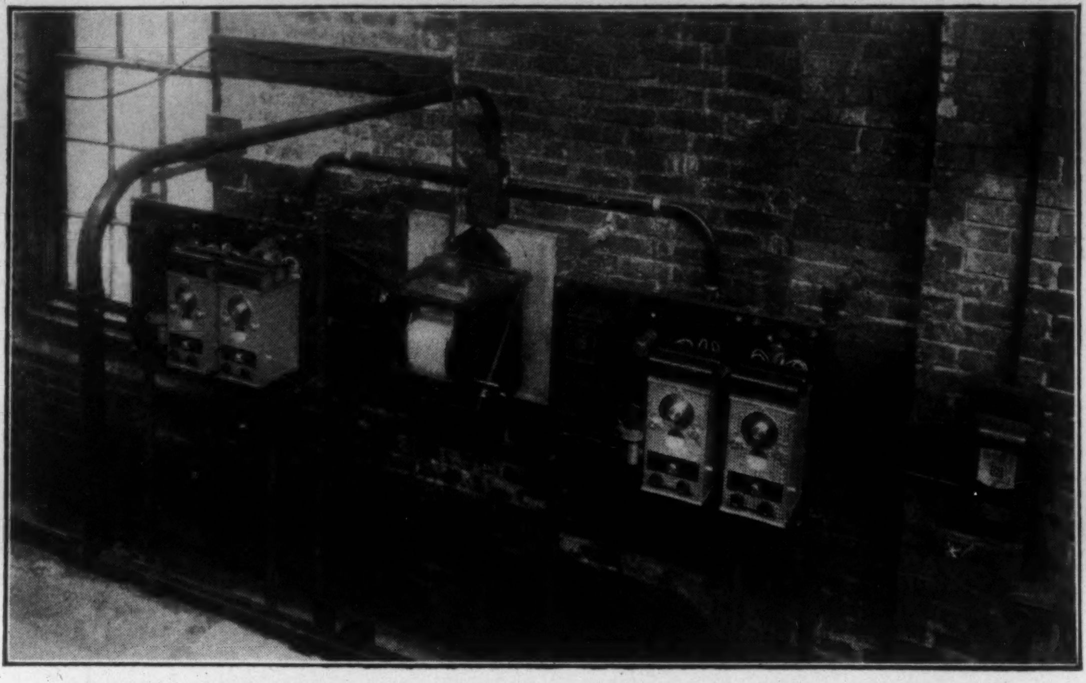

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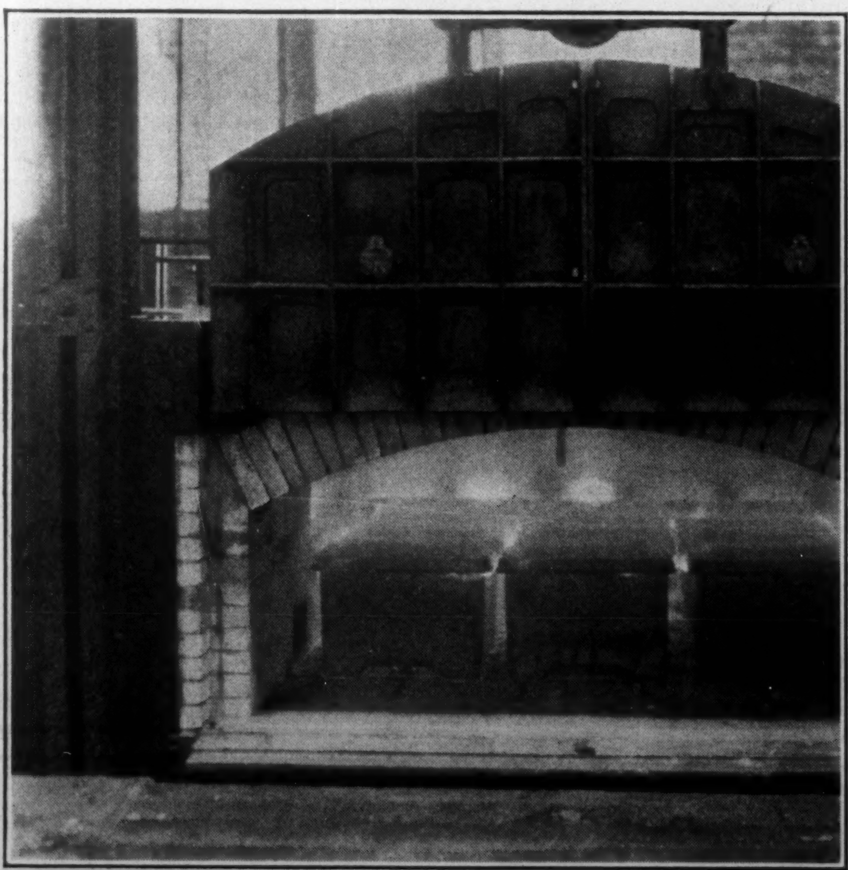

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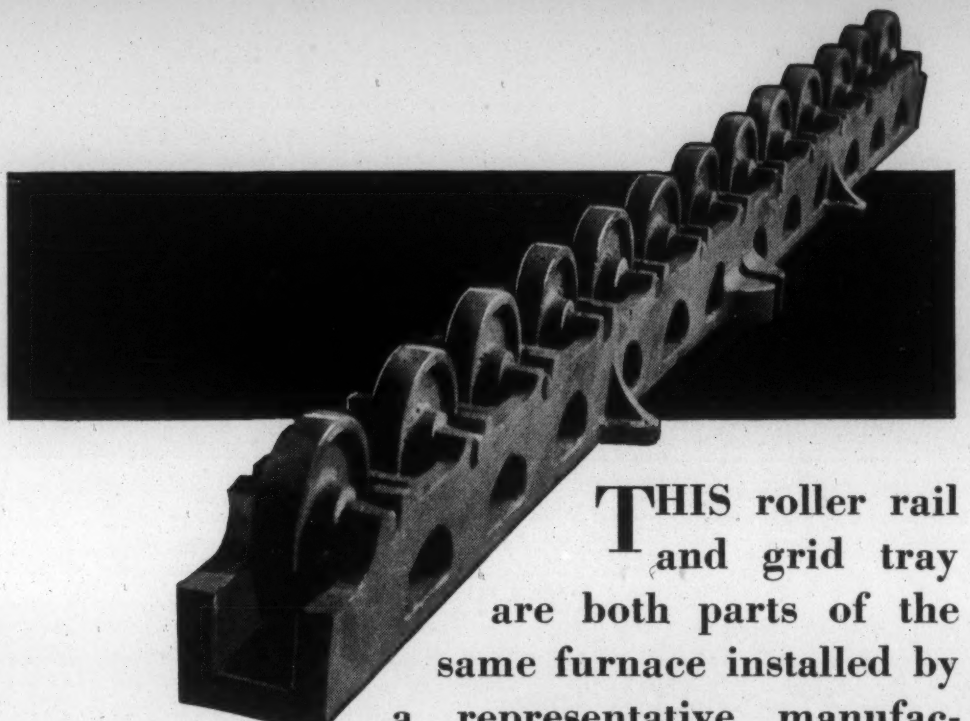
FURNACE PARTS

THAT "STAND THE GRIEF"



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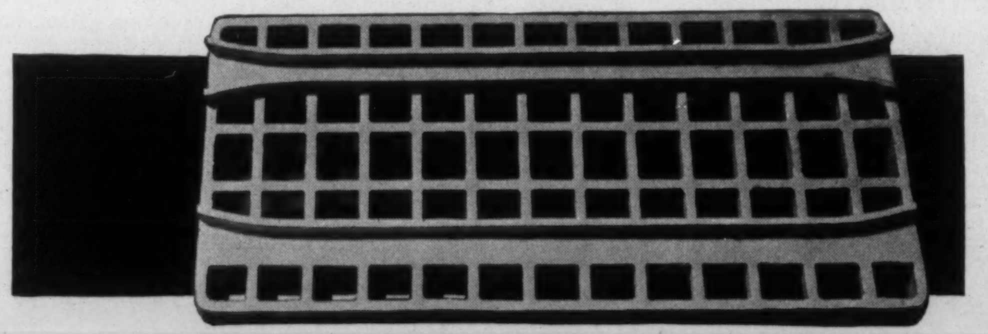

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Thermalloy
HIGH TEMPERATURE
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PUBLISHER'S PAGE

Note— On this page the publishers will talk right straight to you each month. We will tell you how things are progressing with METALS & ALLOYS. *We will undoubtedly ask your advice on many points. We are publishing this paper not primarily to please ourselves but rather to serve you. And our office door is always open. You are invited to call.*

Our Current Literature Abstracts

To assure the readers of METALS & ALLOYS that they receive information pertaining to metallurgical literature the world over we have devised the following system. Abstractors at present cover about 100 domestic and foreign publications and abstract the articles on metals and alloys as well as allied subjects.

1. Upon receipt of these abstracts we check them against our files to avoid duplication: that is, to avoid the repetition of that particular reference as well as to avoid the printing of an abstract of the same article appearing in another publication. If the article, as is often the case with papers read before technical societies, appears in five or six publications we endeavor to have only one abstract appear in our current literature review. The references to this article appearing in other periodicals are then referred to this abstract in METALS & ALLOYS.

2. The abstracts are then rewritten when necessary to conform with our form, after which they are classified under the following heads.

- General
- Properties of Metals
- Properties of Non-Ferrous Alloys
- Properties of Ferrous Alloys
- Corrosion, Erosion, Oxidation, Passivity & Protection of Metals & Alloys
- Structure of Metals & Alloys
  - Metallography & Macrography
  - Structure and X-ray Analysis
- Physical, Mechanical & Magnetic Testing
- Electro-Chemistry
  - Electroplating
  - Electrometallurgy
- Metallic Coatings other than Electroplating
- Industrial Uses & Applications
- Heat Treatment
  - Hardening
  - Annealing
  - Case Hardening & Nitrogen Hardening
  - Quenching
  - Drawing
  - Aging
- Joining of Metals & Alloys
  - Brazing
  - Soldering
  - Welding and Cutting
- Working of Metals & Alloys
  - Melting & Refining
  - Casting & Solidification
  - Rolling
  - Forging
  - Shearing & Punching
  - Extruding
  - Machining
  - Drawing & Stamping
  - Pickling
  - Cold Working
  - Cleaning
  - Grinding
- Defects
- Chemical Analysis
- Historical & Biographical
- Economic
- Plants & Laboratories
- Machinery & Supplies
  - Plant Equipment
- Bibliographies
- Miscellaneous
- Laboratory Apparatus
- Foundry Practice & Appliances
- Furnaces & Fuels
- Refractories & Furnace Materials
- Gases in Metals
- Inspection
- Effects of Elements on Metals & Alloys
- Instruments & Controllers
- Effect of Temperature on Metals & Alloys

3. The following abstract services are constantly checked against ours:
   Engineering Index (Engineering Societies).
   Chemical Abstracts (American Chemical Society).
   Centralblatt der Hütten und Walzwerke (Verein deutscher Eisenhüttenleute).
   Abstracts for papers relating to Non-ferrous Metals and Industries connected therewith (Institute of Metals).
   And others.

4. In preparation for the annual Index our abstract files are kept up to date. All abstracts are filed in three ways, first, according to author, second, according to subject, and third, according to periodical. This permits at all times quickly checking or finding certain information.

The current literature review in METALS & ALLOYS is the most complete review of metallurgical literature available.

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Editorial Comment

In this department I try to comment on metallurgical and allied matters that seem to me interesting and significant. The views expressed reflect my own personal attitude. Many of our readers will have ideas of their own on these subjects and are urged to contribute them in the form of letters which will gladly be published in succeeding issues.—H. W. GILLETT, *Editorial Director.*

Intellectual Honesty

In the translation from the German of the article on page 124 of METALS & ALLOYS for September 1929 there are several tables in which appear such figures as "0.413% Fe, 2.501% Cu, 0.401% Si, 0.532% Mg," these being alloying elements in the aluminum alloys studied. There is no reason to believe that the analyses are dependable to the third decimal, so there is no good reason for reporting them to the third decimal. Even though the original article did carry the figures out so far, it is absurd to repeat them. METALS & ALLOYS will try not to fall into similar absurdities in the future.

People do that sort of thing without thinking. If they stopped to think, they would not only avoid such pseudo-precision, but they could save time. If one is to determine copper in an 80-10-10 alloy, the alloy sample must be weighed as precisely as the electrolytic copper deposit itself. But if he is to determine the presence of one or two hundredths of a percent of phosphorus in the alloy, it is quite immaterial whether the 1 gram sample taken really is 0.9, or 1.1 gram, and weighing to 1.0000 gram is a waste of time. A 2 gram sample of a low carbon steel for carbon combustion does not ordinarily need to be weighed to milligrams since it is seldom that the analysis is of such a precision that 0.50 and 0.52% C are not considered reasonable checks.

Anyone who thinks that ordinary chemical analysis is dependable to the third or fourth significant figure should study the reports of the cooperating analysts on the Bureau of Standards standard samples for chemical analysis, and note the discrepancies even in work done with more than normal care. Really to verify such a figure as 0.532% Mg so one could state it with confidence, would probably cost any laboratory at least fifty dollars in time. In atomic weight work, grave professors will struggle for months to get true agreement in an extra place of decimals, yet many a laboratory will cheerfully report on a single analysis, carried out by a short-cut method, and by a high school helper, to a lot of decimals just because pencil, paper and arithmetic give that result.

One reads a Brinell impression as 3.15 and 3.20 mm. corresponding to 375 and 363 B.H.N. The average would be 369. Does that mean a thing more than a rounded 370 does?

In tensile testing, people will use a testing machine that may never have been calibrated since it left the maker, and which may not be sensitive to 20 lbs. load or accurate to 500, yet because they read a certain figure on the beam at fracture, and divide that by the cross section of the bar, they will report such a figure as 59,873 lbs./in.^{2} tensile strength. If one's testing technique is such that this can fairly be reported as 59,900, with the assurance that it is in reality not more truly 59,800 or 60,000, he is to be congratulated.

How many elongation values in tensile testing are reliable to better than 0.5% and how many reduction of area values to better than 1%? What is the use of reporting single determinations to the significant figures that are common? Even averages of many determinations where the figures themselves show variations of large magnitude are far too often reported to an absurd number of significant figures.

Even the class of people who apply least squares to their data are very prone to kid themselves by starting with so few figures that the application of least squares is a farce.

Transformation of Centigrade to Fahrenheit or of kg./cm.^{2} to lbs./in.^{2} carried out to the exact numerical equivalent when the original figure was properly rounded off to intimate the degree of accuracy, is very common among those who should know better. 54 Kg./mm.^{2} figures over to 76,803 lbs./in.^{2} according to one conversion table, and to 76,842 in another, depending on how many decimals are used in the conversion factor. The 3 and 42 obviously mean nothing. The figure 805° C. should mean that the temperature was above 800° and below 810°, but 806° should mean that it was above 805° and below 807°. It costs money and effort to do work that would justify reporting the temperature as 806°. If that effort has not been expended, it is a type of intellectual dishonesty so to report the figure.

There are figures that can be reported with great exactness. Anyone who attended, or heard over the radio, the "Annual Business Meeting of the Government," will recall the speeches of General Lord, Director of the Bureau of the Budget during the Coolidge administration, who would roll off from memory, the fact that in a certain year, the Government spent "one million, eight hundred seventy six thousand, four hundred twenty six dollars and eighty seven cents" for some purpose or other. The thread of the argument was quite lost in admiration for the speaker's memory, and for the painstaking accounting that established the fact that it was 87 and not 86 or 88 cents. A statement that nearly two million dollars went for that purpose would not have diverted his hearers' mind from the argument.

The British method of reporting tensile figures in tons and one-place decimals of tons, is simple to follow, and generally close enough. The mind can grasp rounded off figures, and figures of a few digits much better than it can longer ones.

One's original notebook may carry out the calculations as far as he likes, but when those figures go into published reports, let us beware of tacitly claiming greater accuracy than we have really attained.

An analogous method of kidding oneself is in the making of specifications. A certain specification for ferro titanium drawn by the usual method of asking the producer what limits of impurities he could stay within, and asking the consumer if he was satisfied with those limits, resulted in setting the silicon limit at 1%. The amount of ferro titanium added to steel as a scavenger is so small that the silicon carried in by even 5% of that impurity would cut no ice whatever in 99% of the steels to which ferro titanium might be added.

When a shipment of ferro was religiously analyzed, found to run nearer 2% Si, and hence rejected, the producer awoke to the fact that with his present ores and methods of production, he could no longer meet the 1% figure he had so glibly stated as satisfactory in earlier years.

Still more absurd is the discussion whether some ferro alloys may or may not contain 0.05% Cu, when the steel to which they will be added already carries, from the scrap used, a similar amount of copper.

Some purchasing agents used to object to 0.10% Ni in ferro vanadium that was to be used in Ni-Cr-V steel, or at least, to charges carrying amounts of nickel from scrap that far overbalanced this "impurity" in the ferro.

If specifications were more often made on the basis of the honest engineering needs of the case in hand, rather than as a compromise fewer foolish specifications would exist. Until these needs are known, it is hypocrisy to draw a detailed specification that purports to cover them.

Readers' Views and Comments

To the Editor of METALS & ALLOYS:

Dear Sir: I am very much interested in Dr. Moldenke's article on recent developments on metallurgy of cast iron which appeared in the January issue of METALS & ALLOYS. I am particularly interested in the last paragraph on page 327; can you tell me if the information in this paragraph applies only to iron which has been melted at high temperatures, and from which the graphite nuclei are absent? Can you tell me of any published articles giving greater detail regarding some of the developments which Dr. Moldenke speaks of. I realize that requests of this sort are time consuming, but hope that you will be able to tell me where I can get the information which I am looking for.

Yours very truly,

E. L. WOOD

Landers, Frary & Clark
New Britain, Connecticut

Dear Mr. Wood: Your valued letter of the 28th Ult., was sent on to me by METALS & ALLOYS for reply. I take it you refer to running the silicon down low enough to bring out an almost white iron casting—but also an almost gray casting—which when annealed exhibits properties like unto the malleable casting, the molten metal being in a state of extreme superheat, with the graphite nuclei conspicuous by their almost total absence. Necessarily, to get the total carbon down as low as it must be for this situation, the mixture is almost an all-steel one. Hence, the phosphorus is around 0.10, or within the range of "Malleable" compositions.

One of the interesting discoveries connected with the making of high-test cast iron was the action of the molten metal in cooling down. Whereas, in ordinary practice it makes quite a difference whether a mold is filled with very hot iron, or is poured off cold—the castings show very different fractures when of certain compositions as you must know from your malleable experience—it seems that with high-test cast iron this is not so much the case. Here, it seems to make little difference whether the iron is allowed to cool down to proper pouring temperature while in the ladle, or whether it cools down thusly, directly in the mold. The absence of graphite nuclei seems to account for this property, for crystalline graphite is not formed in the act of setting until just that temperature of setting is reached—in the downward course. Hence, also, it seems to make little difference what section thickness is involved, whether 12″ thick or 1″. Graphite crystals do not form in either until the temperature is low enough for this, and Piwowarsky has found that this temperature of freezing, the absence of graphite nuclei, is actually lower than the normal—that is, with graphite nuclei present. The metal is "sub-cooled" (or, I believe he calls it "super-cooled"). This accounts for the fact that I have seen heavy and light sections broken from the same large casting (in Germany with an identical fracture). Imagine what you would have with ordinary practice for fractures in the same casting in an 8″ thick section with a 1″ rib running into it.

While little is published on this particular phase of the developments with high-test cast iron—for those who make these castings like to retain the monopoly of making them—there is known just what I gave in the paragraph in question. That is, if the casting has the silicon lowered to the point of giving a mottled fracture and a high-temperature anneal is given it, the fracture will become finely gray, and you can sledge a boss into a curve, or twist and bend the casting to a considerable extent. The strength, moreover, runs into 70,000 lbs. per sq. in. and with a high nickel percentage over 100,000 lbs.

Considering that you cannot make an ordinary malleable casting over $^{3}/_{4}''$ thick unless you plaster the mold with chills, you can see what value this development has for the producer of malleable castings, if he cares to invade the heavy castings market. Beyond the making of heavy castings annealed to gray fractures, I have not seen straight malleable mixtures tried that way yet, probably because no malleable concern is fixed to do it. It is really a malleable cupola proposition, and I would certainly be interested in seeing the matter taken up practically. If I can help in any way, command me. As stated, there is practically nothing published on this point, and what information I obtained was by talking it over with my German friends.

Very truly yours,

RICHARD MOLDENKE

Watchung, N. J.

To the Editor of METALS & ALLOYS:

Dear Sir: We think that some mention of the opportunities for special study and facilities available at the University of Michigan may be of interest to your readers.

Certain courses deal with metallurgical subjects. We do not, however, believe in giving under-graduate students sharply specialized training in any specific field. It is our experience that they succeed better with a broad fundamental training in Chemical Engineering and with specialization reserved for graduate work.

One of the important developments in recent years has been the demand from the industries for men with graduate training. This is reflected in the growth of our graduate work. During the present academic year there are 42 graduate students enrolled in the Department of Chemical and Metallurgical Engineering at the University of Michigan, of whom 20 already have the Master's degree and are working for the Doctorate. The East Engineering Building gives unusual facilities for advanced laboratory work.

The Department of Engineering Research has important contacts with the chemical industry and several industrial fellowships will be available for graduate students next year.

Copies of the bulletin giving details as to our courses may be secured by writing the Chemical Engineering Department, University of Michigan, Ann Arbor, Michigan.

We hope you will advise your readers of the opportunities offered for graduate work and of the fellowships that are open.

Very truly yours,

ALFRED H. WHITE

Professor of Chemical Engineering
University of Michigan
Ann Arbor, Michigan

Oxygen Research at Mellon Institute

Dr. E. R. Weidlein, Director, Mellon Institute of Industrial Research, Pittsburgh, Pa., has announced the appointment of H. E. Foote (Ph.D., Brown University, 1917) to the incumbency of the Institute's Industrial Fellowship on Oxygen. This Fellowship has been established by the Gas Industries Company, Inc., Pittsburgh, Pa., designer and builder of liquid-air oxygen apparatus. The investigation is to be concerned with the extension of the present uses of oxygen, and in particular with the application of cheap oxygen in various industrial processes, including metallurgical operations and technically important organic oxidation reactions.

Dr. Foote has been a member of the Institute's investigational staff since 1927. He was previously engaged in research at the Philippine Bureau of Science, Manila, P. I.

Mining and Metallurgical Investigations

A 14-page booklet, giving the research program for 1930 and a list of publications on mining and metallurgical investigations under the auspices of the United States Bureau of Mines, the Carnegie Institute of Technology, and the Mining and Metallurgical Advisory Boards is being distributed by the Carnegie Institute of Technology, Pittsburgh, Pa. The bulletin also lists the members of the advisory boards and the contributors and cooperators in past and present research studies.

New Journal on Scientific Instruments

The Optical Society of America, after publishing under one cover for eight years its journal and a section devoted to original articles on scientific instruments and methods of all kinds, has now separated these two classes of material and has established a new publication. This is to be called the "Review of Scientific Instruments" the first number of which appeared in January. This separate journal is devoted exclusively to scientific instruments, and the Journal of the Optical Society will continue to publish, as heretofore, original articles in the optical field. Dr. Paul D. Foote, Gulf Research Laboratory, Pittsburgh, Pa., is editor-in-chief of both publications.

Age Hardening Lead-Calcium Alloys

By Earle E. Schumacher and George M. Bouton*

> *Although some authorities question whether precipitation of hardening particles is the chief, or even the real, cause of the Duralumin type of age hardening, that hypothesis continues to serve as guiding star for many a useful metallurgical research. It is unlikely that without that idea as a guide, we would be on the way to the condition of fewer interruptions in telephone service due to failure of cable sheath, presaged in this article.*
>
> *Deep-mining, rather than surface prospecting, is characteristic of much modern metallurgical research. Here is an investigation relating chiefly to a binary alloy of lead with less than 0.1% of calcium. Variations of 0.001% in calcium are taken into account, and alloys had to be aged at 30 ± 0.03° C. for 18 months, in order to give data of the necessary accuracy.*

The system lead–calcium has been reported upon in considerable detail by Caron,[1] Donski[2] and N. Baar.[3] The thermal analysis and microscopic data resulting from these investigations lead to the diagram shown in Fig. 1. The system is characterized by the presence of the compounds Pb_3Ca, PbCa and $PbCa_2$. The existence of these compounds is confirmed by work done by Ufford[4] and by Kremann, Wostall and Schöpfer.[5] Only alloys in the range between pure lead and Pb_3Ca are at present of commercial interest. Other investigators[6] have studied the physical properties of lead alloys containing up to 2% calcium with a view to their use as bearing materials. In these alloys, large particles of the compound Pb_3Ca cause hardening and furnish bearing surfaces. In the studies, made by the writers, of lead calcium alloys for use as cable sheathing material, the existence of solid solubility of Ca (or Pb_3Ca)† in lead was shown by the discovery of a definite range of age hardening alloys. This result is in essential agreement with independent studies made by Dean and Ryjord[7].

Some of these hardenable alloys possess properties which strongly recommend them for commercial uses.†† Compared with the lead-1% antimony alloy, which is generally recognized as one of the best cable sheathing materials, the lead-calcium alloys develop greater fatigue resistance, tensile strength and hardness. These properties reach nearly constant values shortly after extrusion because of the rapid rate of precipitation of calcium from solid solution, and the slow rate of diffusion and agglomeration of calcium (or the molecule Pb_3Ca). The lead-1% antimony alloy continues to change even after a period of years. Experiments on corrosion resistance show the lead-calcium alloys to be so little different from the lead-1% antimony alloy as to have no appreciable effect on the life of a cable.

In order to predict the behavior of these alloys more completely, a detailed study has been made of the location of the liquidus, solidus and solid solubility curves near the lead end of the system, and a number of experiments have been made to determine the reaction of these alloys to heat treatment. An account of some of these studies is presented in this paper.

Thermal Analysis

The thermal data reported by Donski[8] and Baar[9] have been checked on alloys containing up to 1.0% calcium. Particular attention was given to the temperature of the solidus arrest. Metallic calcium, which by spectroscopic examination was shown to be of very high purity, was added to Bunker Hill[10] lead (analyzing Ag, 0.0006%; Cu, 0.0004%; Sb, 0.0037%; Fe, 0.0013%; Bi, 0.0014%; Pb, balance), to make a 3% calcium addition mixture. The metals were alloyed at 850° C. in an atmosphere of argon. The solution of the calcium in the lead was accompanied by the evolution of considerable heat, indicating the formation of a compound. For the cooling curves, a melt of about 400 grams was made from Bunker Hill lead and that quantity of addition mixture necessary to give the desired composition. The materials were heated together in an evacuated pyrex glass tube to 600° C. and held there for half an hour to insure uniform

---

* Member of Technical Staff, Bell Telephone Laboratories.

[1] H. Caron, *Lieb. Ann.*, **1859**, page 111.

[2] L. Donski, *Zeit. für anorg. Chem.*, **57**, 185–219 (1908).

[3] N. Baar, *Zeit. für anorg. Chem.*, **70**, 352–394 (1911).

[4] W. C. Ufford, *Proc. Am. Acad. of Arts and Sc.*, **63**, 309–328 (1928).

[5] Kremann, Wostall and Schöpfer, *Forschungsarbeiten zur Metallkunde* No. 5, 1922.

[6] W. A. Cowan, L. D. Simkins and G. O. Hiers, *Trans. Am. Elect. Chem. Soc.*, **40**, 27–48 (1921).

† The stability of the compound Pb_3Ca in solid solution has not as yet been established.

[7] Dean and Ryjord, METALS & ALLOYS, March 1930.

†† All results presented in this paper were obtained from laboratory tests. Data from extensive field tests which are now in progress will, of course, be the final criterion for evaluating the usefulness of these materials for practical purposes.

[8] L. Donski, *loc. cit.*

[9] N. Baar, *loc. cit.*

[10] Lead of this grade was used in making all of the alloys reported upon in this paper.

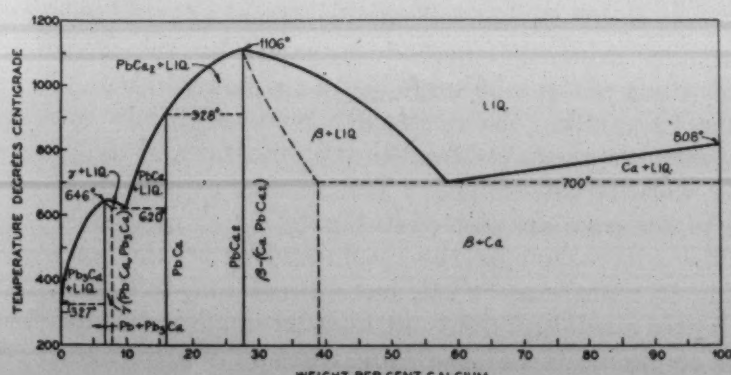

Fig. 1—Constitutional Diagram of the System Lead–Calcium According to L. Donski and N. Baar

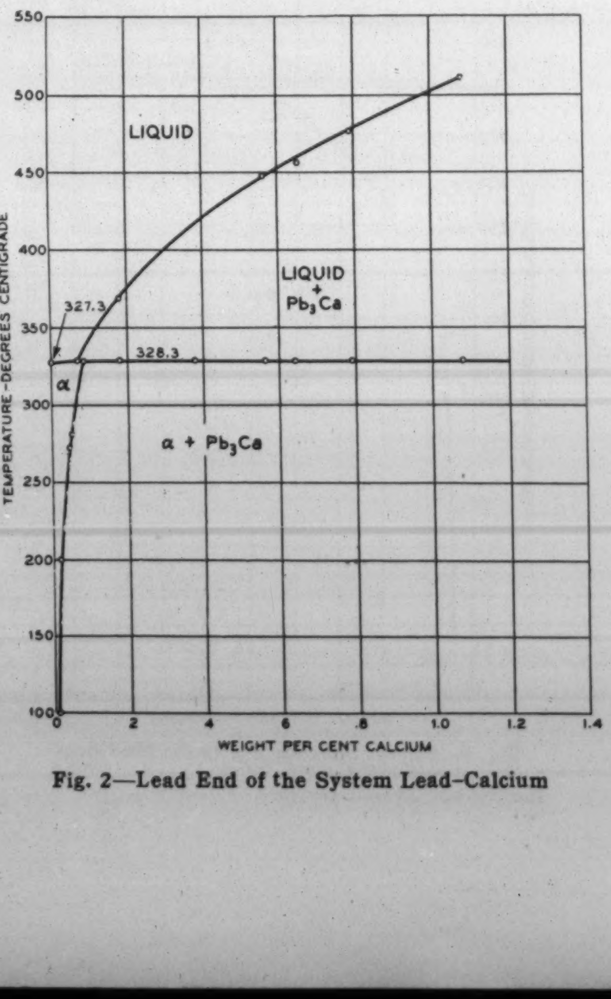

Fig. 2—Lead End of the System Lead–Calcium

temperature of the furnace and apparatus. Argon was then admitted into the tube to prevent access of air and the melt cooled at the rate of 6° C. per minute. Constant stirring was provided by a magnetically driven glass mixer. Temperature determinations were made at one minute intervals by means of a quartz sheathed iron-constantan thermocouple (0.25 mm. diam. wire) and a Leeds and Northrup type K potentiometer. After each run, the thermocouple was calibrated against the freezing points of Al, Zn and Pb temperature standards furnished by the U. S. Bureau of Standards. At the end of each test, in order to check the composition, the alloys were remelted and stirred, and three samples were taken with glass pipettes. This procedure was necessary because of the tendency of the lighter Pb_3Ca to segregate near the top of the melt during freezing. Each of the pipetted samples was completely dissolved and analyzed. The results obtained are given in Table I and plotted in Fig. 2.

Table I—Thermal Data on Lead-Calcium Alloys

Weight Percent Calcium	Liquidus Arrest° C.	Solidus Arrest ° C.
0.00	327.3	327.3
0.02	327.6	...
0.04	328.0	...
0.07	328.3	328.3
0.18	368	328.3
0.37	418	328.3
0.56	447	328.3
0.65	454	328.3
0.79	475	328.3
1.09	511	328.3

The liquidus agrees quite closely with that of N. Baar.[11] It is significant, however, that the time-temperature cooling curves of all alloys containing 0.07% Ca or more show horizontal portions about one degree above the melting point of lead. This indicates a peritectic reaction at the extreme lead end of the system. Fig. 3 shows this region on a magnified scale. It was not possible to determine the exact location of the solidus between point B and pure lead by the method used because of the narrow temperature range involved.

Microscopic Examination

Chill cast alloys containing more than 0.07% Ca show primary crystallites of Pb_3Ca. However, in specimens containing less than 0.10% Ca, all of these particles can be dissolved by heating at 326° C. for one half hour. This shows the approximate location of the point A, Fig. 3, and the limit of solid solubility B. The photomicrograph, Fig. 4, shows a specimen containing 0.11% Ca which was chill cast to suppress the peritectic reaction. Fig. 5 is a photomicrograph of the same specimen after being heated at 326° C. and shows evidence of the peritectic reaction.

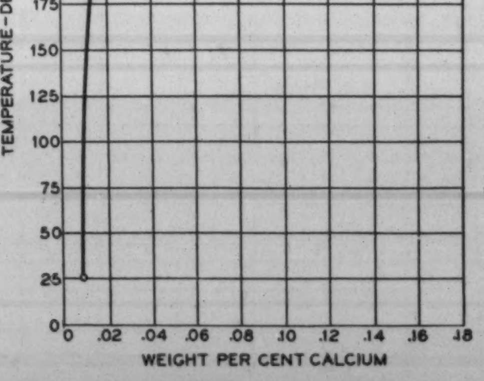

Fig. 3—Curves Showing Peritectic Modification and Solid Solubility at the Lead End of the System Lead-Calcium

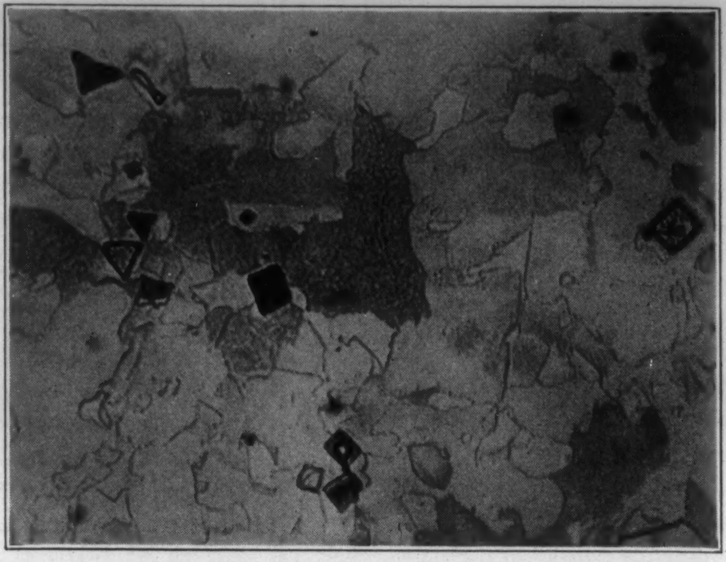

Fig. 4—Photomicrograph of a Pb-0.11% Ca Alloy Which Was Chill Cast to Suppress the Peritectic Reaction. × 500. (Reduced 25%.) Etched with a Solution of 3 Parts Glacial Acetic Acid and 1 Part Superoxol (30 % Hydrogen Peroxide)

Electrical Conductivity

The solid solubility of calcium in lead at 30° C. was determined by a study of the electrical conductivity of a series of wires containing various concentrations of calcium. The wires were annealed in vacuum for one half hour at 310° C. and quenched. They were then immediately placed in a thermostat held at 30° C. ± 0.03° C. and the precipitation of Pb_3Ca from those alloys that were supersaturated with calcium at 30° C. was followed by means of resistance measurements using the method employed by the writers[12] in their study of the solid solubility of antimony in lead. When, after 18 months, the resistances were essentially constant, the wires were removed from the thermostat and their lengths and weights determined. The results expressed in mhos per meter gram are plotted in Fig. 6.

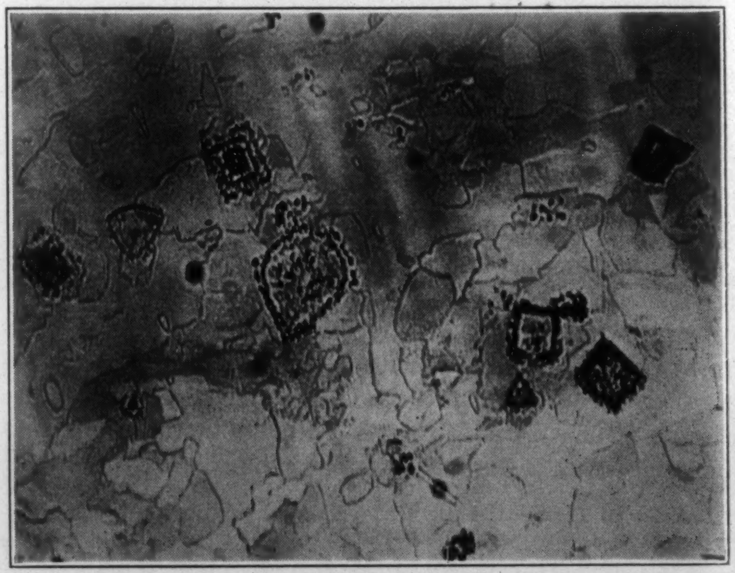

Fig. 5—Photomicrograph of Specimen Shown in Fig. 4 After It Had Been Heated at 326° C. for Thirty Minutes. The Disintegrated Appearance of the Crystallites of Pb_3Ca is the Result of the Peritectic Reaction. × 500. (Reduced 25%.)

The curve showing the conductivities of the wires after aging 18 months at 30° C. has a break at 0.01% Ca. This indicates a solid solubility at least as small as this at 30° C. The conductivities of the same wires in the quenched condition are also given in Fig. 6.

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[11] N. Baar, *loc. cit.*

[12] Schumacher and Bouton, *Jl. Amer. Chem. Soc.*, **49**, 1667–1675 (1927).

Hardness Studies

Additional data on the location of the solid solubility curve were obtained by a study of the age hardening phenomena. An attempt was made to determine the temperature at which an 0.04% Ca solid solution becomes saturated. For this purpose, six flat specimens 3.2 mm. thick were heated in an oil bath to 308° C. and held there for 1/2 hour. One specimen was quenched and its hardness measured. The rest were allowed to cool in the oil bath to various lower temperatures. A specimen was quenched after the lot had remained at each temperature for 1/2 hour. Their hardness was measured immediately after quenching and also after aging at room temperature for various periods. Hardness was measured by means of a standard Rockwell Hardness Tester which was modified to permit the application of a 30 kg. load. A 1/4" ball penetrator and 2" ball anvil were used. Readings were taken on the "B" scale after the full load had been applied for one minute. This procedure defines the "soft metal (SM) scale" referred to herein. The results obtained are given in Table II.

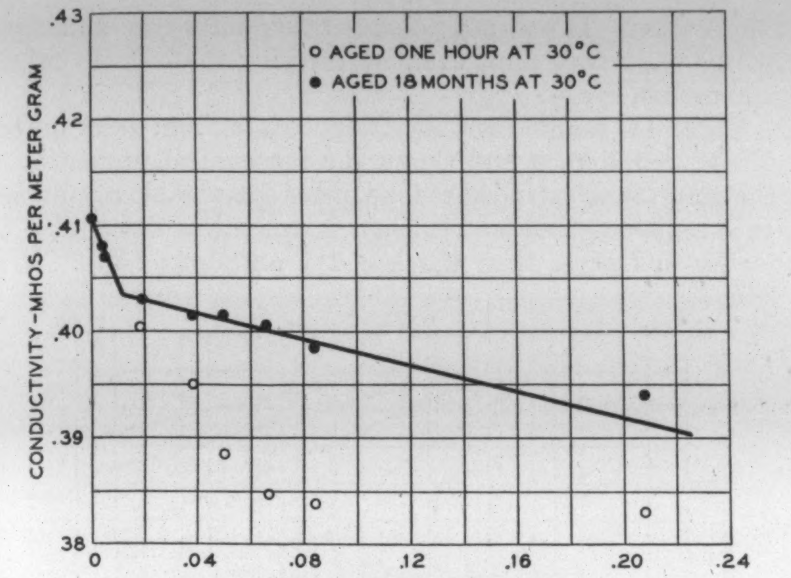

Fig. 6—Electrical Conductivity of Lead-Calcium Alloys at 30° C.

Table II—Effect of Quenching Temperature on the Age Hardening of a Pb-0.04% Ca Alloy

Spec. No.	Quench Temp. ° C.	Rockwell Hardness (SM) Scale As Quenched	Aged 1 Day	Aged 5 Days	Aged 14 Days
1	308	< −45	66	68	72
2	286	< −45	65	70	72
3	264	< −45	63	70	70
4	248	< −45	66	70	70
5	228	< −45	67	71	72
6	200	< −45	59	60	64

It will be noticed that in every case except specimen number 6 the rate and degree of hardening was approximately the same. These data indicate that the Pb-0.04% Ca solid solution first begins to expel calcium at some temperature between 228 and 200° C. However, other data, which will be discussed in the following paragraph, indicate that calcium must have been in supersaturated solution even at temperatures considerably higher than this.

This additional information on the location of the solid solution line was obtained by determining the lowest temperature at which 0.04% Ca entirely dissolves in solid lead. Samples of the Pb-0.04% Ca alloy were brought to a uniform, hardened condition by heating them at 300° C. for 1/2 hour, quenching and aging one day at room temperature. Specimens were then heated to various elevated temperatures until hardness readings showed that equilibrium conditions had been reached. They were then quenched and their aging at room temperature followed by hardness measurements. The results obtained are plotted in Fig. 7.

These data indicate that complete solution of the calcium did not take place until a temperature of about 265° C. was reached. Accordingly, the curve of solid solubility crosses the 0.04% calcium coordinate very near this point. The temperatures 200 and 280° C. at which the 0.016% Ca and the 0.05% Ca alloys respectively become saturated solid solutions were obtained in a similar manner.

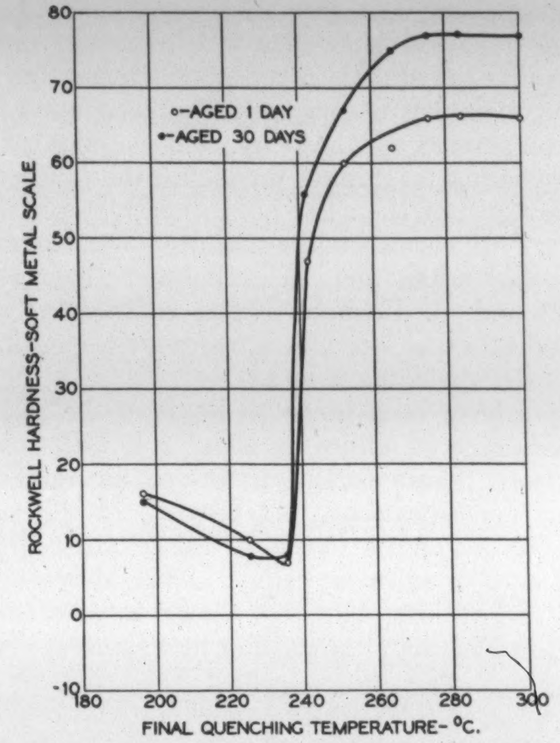

Fig. 7—Hardening of a Lead-0.04% Calcium Alloy After Quenching from Various Temperatures

Tensile Strength Studies

Tensile strength tests were made on a series of alloys containing various concentrations of calcium. These results are plotted in Fig. 8 and show the values for the specimens as quenched and as aged 18 months at room temperature. It should be noted that there is a definite age hardening in alloys containing as little as 0.01% Ca. This indicates that the solid solubility at room temperature is somewhat less than 0.01%.

As a result of the investigations described, the solid solubility curve (Fig. 3) can now be located. The maximum solid solubility near the peritectic temperature was found to be 0.10% Ca by microscopic examination; the lower limit of solubility at 25° C. was found to be approximately 0.01% Ca by both age hardening and conductivity experiments; three points, 0.016% Ca at 200° C., 0.04% Ca at 265° C. and 0.05% Ca at 280° C., were found by age hardening experiments.

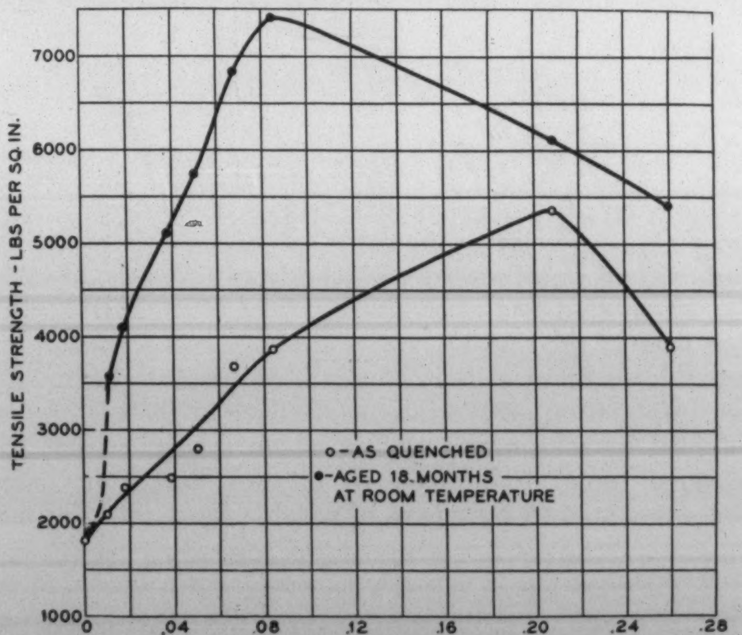

Fig. 8—Effect of Calcium Concentration on the Tensile Strength of Quenched and Aged Pb-Ca Alloys

Fatigue Resistance of Lead-Calcium Alloys

In the past few years, a number of investigators have studied the failure of lead cable sheath by cracking. After the investigation of many possible causes for this type of failure, it has become quite generally recognized that the alternate stresses caused by vibration or daily or seasonal temperature changes are primarily responsible. J. R. Townsend[13] has described a machine which subjects specimens of cable sheathing material to repeated stresses and produces failures very similar in appearance to those found in service. It must be pointed out, however, that the number of cycles of corresponding magnitude producing the failures in these tests is far greater than has been directly accounted for in the history of corresponding failures of cable sheaths in service. Beckinsale and Waterhouse,[14] Dunsheath and Tunstall[15] and O. Haehnel[16] have contributed additional data to indicate that alternate stresses are responsible for the common intercrystalline failure.

Attempts have been made to improve the resistance of lead to this type of failure by alloying it with one or more other metals. Those usually considered are Sn, Sb and Cd in various concentrations. At present, in this country a large proportion of the telephone cables are being covered with a lead-1% antimony alloy. This alloy can be age hardened and has been shown to possess considerably greater fatigue resistance than pure lead or lead tin alloys containing up to 3% Sn. It has one decided disadvantage, however, in that agglomeration of the precipitated particles takes place rapidly at room temperature, particularly when the alloy is cold worked. This agglomeration is most pronounced near the grain boundaries and leaves large areas in this region unstrengthened by the dispersed phase.

Laboratory experiments indicate that the age hardening lead-calcium alloys discussed here are far less susceptible to failure by fatigue than the Pb-1% Sb alloy. Townsend[17] has shown that the lead-1% antimony alloy fails after about two million cycles at 0.11 inches deflection on the machine described by him. Table III shows the results of tests made on several lead-calcium alloys on the same machine. The specimens were cut from extruded tape which had aged one month at room temperature.

Table III—Physical Properties of Lead-Calcium Alloys Subjected to Fatigue Test[18]

Alloy Number	1	2	3	4
Weight Percent Calcium	0.041	0.042	0.040	0.054
Extrusion Temp. ° C.	240	250	270	230
Rockwell Hardness Soft Metal Scale	47	60	74	28
Tensile Strength, lbs./in.^{2}	3290	4128	4370	2835
Percent Elong. in 2″	41	32	32	38
Fatigue Resistance Cycles of Stress × 10^{-6}	51.4*	40*	40*	79*
	28.9	40*	40*	79*
	18.6	40*	40*	79*
	51.4*	40*	40*	26
	51.4*	40*	40*	79*
	51.4*	44*	44*	79*
		44*	44*	79*

* Specimens removed from the machine unbroken.

These results on alloys having a large range of tensile properties show clearly the superior fatigue resistance of the lead-calcium as compared with the lead-1% antimony alloy. The stress produced in these tests is higher than the endurance limit of the lead-1% antimony alloy and probably lower than the endurance limit of the lead-calcium alloys. Further information on the fatigue strength of these alloys was obtained by means of a test in which specimens, cut from extruded round rod, acted as rotating cantilever beams. Stress was applied by means of weights hung on roller bearings at the free end of the specimens. The specimens were rotated at a speed of 800 cycles per minute. Tests were made on a number of alloys in order to study the effect of calcium concentration and of aging at room temperature. Fig. 9 shows the results obtained with pure lead, a lead-1% antimony alloy and with two lead-calcium alloys whose physical properties are such that they may find commercial application. It was not possible to obtain a true indication of the endurance limit even by carrying the tests to nearly 100 million cycles.

Table IV summarizes the fatigue data from tests on extruded round rods and shows the mechanical properties of the same alloys extruded as tape under comparable conditions. It is apparent that lead-calcium is much less susceptible to failure in fatigue than the lead-1% antimony alloy. It is also shown that fatigue strength increases along with tensile strength when the alloy age-hardens. The data on the 0.06% Ca alloy show the effect on the mechanical properties of increasing the calcium concentration.

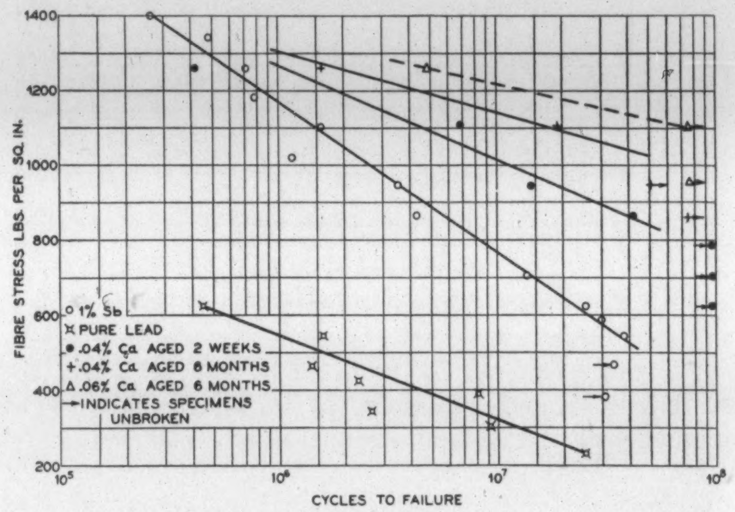

Fig. 9—Comparison of the Fatigue Resistance of Lead-Antimony and Lead-Calcium Alloys

Table IV—Fatigue Resistance and Other Mechanical Properties of Lead Alloys

	Rotating Beam Fatigue Test		Properties of Extruded Tape		
Material	Lowest Breaking Stress lbs./in.^{2}	Highest Sustained Stress lbs./in.^{2}	Tensile Strength lbs./in.^{2}	Per-cent Elong. in 2″	Rockwell Hardness S.M.Scale
Pb—1% Sb Aged 6 months at room temp.	545	466	3000	37	42
Pb—0.040% Ca Aged 2 weeks at room temp.	863	784	3470	33	58
Pb—0.040% Ca Aged 6 months at room temp	1101	943	4145	35	64
Pb—0.06% Ca Aged 6 months at room temp.	1259	1101	4365	35	65

Effect of Double Aging on Lead-Calcium Alloys

During the study of the effect of aging temperature on the rate and degree of hardening of lead-calcium alloys, it was found that lead alloys containing 0.01 - 0.07% Ca do not develop as great hardness when aged at 100° C. immediately after quenching as when they are aged at room temperature. However, if the alloys which have aged one day at room temperature are then aged at 100° C. the hardness attained during the first day at the higher temperature exceeds that produced by aging only at room temperature for one month. Fig. 10 illustrates the effect of double aging in a Pb-0.04% Ca alloy which was extruded at 270° C. The phenomenon perhaps can be explained as an effect of the relative rates of precipitation and agglomeration on the size of the precipitated particles.

Summary

The lead end of the system lead–calcium has been investigated and a constitutional diagram given. A peritectic reaction has been discovered and the solid solubility of cal-

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[13] J. R. Townsend, *Proc. Am. Soc. Test. Mat.*, **27**, Part 2, 153–166 (1927).
[14] S. Beckinsale and H. Waterhouse, *Metal Industry, London*, **32**, 302–307 (1928).
[15] P. Dunsheath and H. A. Tunstall, *Jl. Inst. E. E.*, **66**, 280–289 (1928).
[16] O. Haehnel, *Zeit. für Metallkunde*, **19**, 492–496 (1927).
[17] J. R. Townsend, *loc. cit.*
[18] The data on mechanical properties given in Tables III and IV were obtained from tests made under the direction of J. R. Townsend.

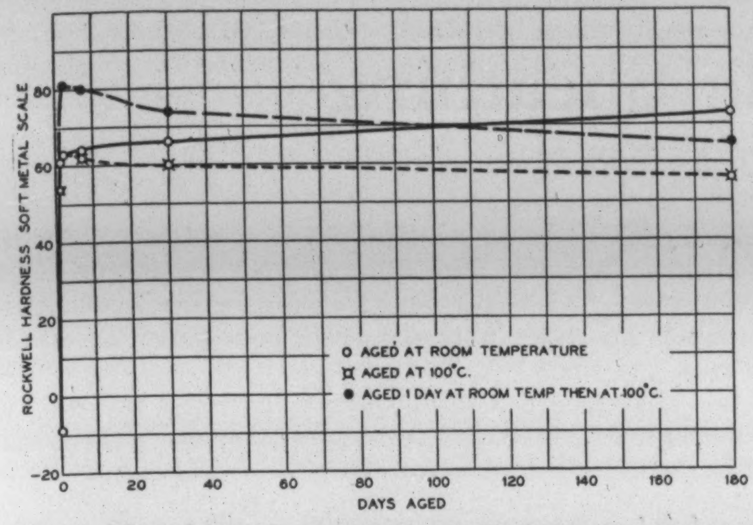


Fig. 10—Effect of Aging Temperature on the Hardening of a Pb-0.04% Ca Alloy

cium in lead has been determined for five temperatures. The solubility changes from 0.1% calcium at 328.3° C. to approximately 0.01% calcium at 25° C. Data for locating the solid solubility curve were obtained from thermal analyses, electrical conductivity measurements, microscopic examinations and age hardening studies.

It has been shown on the basis of laboratory tests that greater tensile strengths and resistances to fatigue failure can be developed in some of the lead-calcium alloys than in the lead-1% antimony alloy. Certain lead-calcium alloys have been suggested as sheathing materials for electrical cables.

Acknowledgment

The authors wish to express their thanks to Professor C. H. Mathewson and Dr. J. E. Harris to whom they are especially indebted for helpful advice.

Calendar of Meetings

Symposium on Automotive Materials (A. S. T. M.) Book-Cadillac Hotel, Detroit, Mich., March 19.

Franklin Institute, Philadelphia, Pa., March 19, April 3, April 10.

American Society of Mechanical Engineers, New York, N. Y., April 5.

All American Aircraft Show, Detroit, Mich., April 5–13.

American Chemical Society, Atlanta, Georgia, April 7–11.

National Metal Trades Association, Hotel Astor, New York, N. Y., April 16–17.

American Welding Society, New York, N. Y., April 23–25.

National Academy of Sciences, Washington, D. C., April 28–30.

American Iron & Steel Institute, Hotel Commodore, New York, N. Y., May 9.

American Foundrymen's Association, Cleveland, Ohio, May 12–17.

American Society of Mechanical Engineers, Fourth National Aeronautic Meeting, Dayton, Ohio, May 19–22.

American Electrochemical Society, St. Louis, Mo., May 29–31.

American Institute of Chemical Engineers, Book-Cadillac Hotel, Detroit, Mich., June 4–6.

Association of Iron & Steel Electrical Engineers, Buffalo, N. Y., June 16–20.

American Railway Association Convention, Atlantic City, N. J., June 18–25.

World Power Conference, Berlin, Germany, June 16-25.

American Society for Testing Materials, Haddon Hall, Atlantic City, N. J. June 23-27.

Society for the Promotion of Engineering Education, Montreal, Canada, June 26-28.

Société de Chimie Industrielle, Liege, Belgium, Sept. 21–27.

National Metal Congress and Exposition, Hotel Stevens, Chicago, Ill., Sept. 22–27.

British Cast Iron Research Association, London, England, Oct. 29.

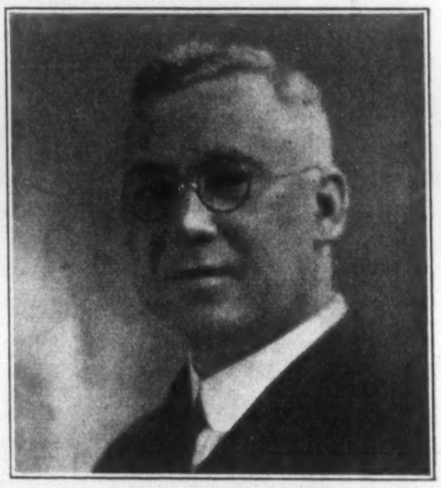
American Gas Association, Atlantic City, N. J., Oct. 13–17.

Association for the Advancement of Science, Cleveland, Ohio, Dec. 29–Jan. 31, 1931.

At a meeting of the Nominating Committee of the American Foundrymen's Association held at Cleveland, January 13, 1930 the following were nominated for Officers and Directors:

For President, to serve one year:
N. K. B. Patch, Secretary. Lumen Bearing Co., Buffalo, N. Y.
For Vice-President, to serve one year:
E. H. Ballard, General Foundry and Pattern Shop Superintendent, General Electric Co., West Lynn, Mass.
For Directors, each to serve three years:
C. S. Anderson, Vice-President and General Manager, Belle City Malleable Iron Co., Racine, Wis.
H. R. Culling, Vice-President, Carondelet Foundry Co., St. Louis, Mo.
Fred Erb, President, Erb-Joyce Foundry Co., Detroit, Mich.
R. M. Maull, Treasurer, Tabor Mfg. Co., Philadelphia, Pa.
D. M. Scott, Vice-President, Gould Coupler Co., Depew, N. Y., and the Symington Co., Rochester, N. Y.

Thorsten Y. Olsen, President Olsen Testing Machine Company



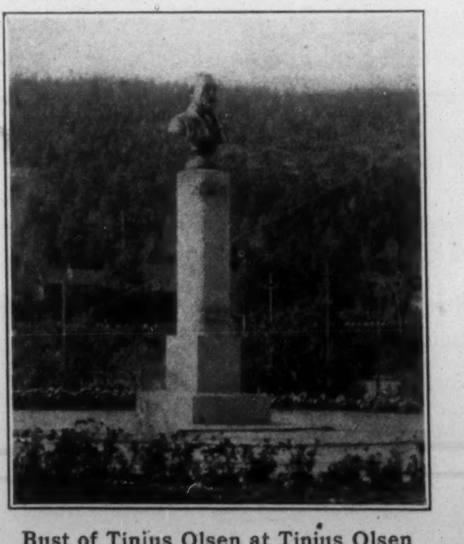
Thorsten Y. Olsen

With the resignation of Tinius Olsen, pioneer builder of testing machines, founder and president of the Tinius Olsen Testing Machine Co. of Philadelphia, his son Thorsten Y. Olsen was elected president. Mr. H. W. Boyd for many years superintendent and secretary, which positions he will continue to hold, was elected vice-president to succeed Mr. T. Y. Olsen who will retain the office of treasurer.

After many years of training in the plant, and his graduation in 1903 from Cornell University, T. Y. Olsen became superintendent. In 1912 he was elected vice-president. Mr. Olsen is a member of the S. A. E., the A. S. M. E., the A. S. T. M. and other organizations.

Tinius Olsen, now in his 84th year, a native of Kongsberg, Norway, came to this county in the late 60's. He was employed by William Sellers & Co., and other machine builders until he founded his own company to manufacture testing machines. In recent years Mr. Olsen was knighted on two occasions by the King of Norway.

Mr. Olsen has endowed a technical school in his native town to be built about the Tinius Olsen Plads, a square named for him in recognition of his benefaction. The school is to be conducted similarly to the Drexel Institute in Philadelphia, providing the scientific education for both sexes in day and evening classes that Mr. Olsen found so difficult to obtain for himself.



Bust of Tinius Olsen at Tinius Olsen Plads, Kongsberg, Norway

The Babcock and Wilcox Co., has placed on the market a new gas fired laboratory furnace said to possess several novel features. This device has many uses in the laboratory and the maker calls attention to it for calibrating thermocouples from the freezing points of metals, making melts of non-ferrous alloys, etc.

Alloys for Cable Sheathing

By R. S. Dean and J. E. Ryjord*

The first cable sheathing was made of pure lead. While this material is still used in some instances, particularly in power cables, it was gradually replaced with an alloy of lead with 1–3% tin due to the greater strength of the latter, as well as greater resistance to certain types of corrosion. In 1907 the Bell System began an investigation to develop a cable sheath alloy which would be as good as the tin alloy, but cheaper. This resulted in the adoption of the 1% antimony, 99% lead, as the standard sheathing for telephone cables. In 1920 when the present investigation was started, by far the larger proportion of telephone cables made by the Bell System was sheathed with lead-antimony. This investigation, therefore, started with this alloy.

Properties Desirable for Cable Sheath

Cable sheath alloys must necessarily be pliable so that they may be easily reeled and unreeled. Further, they must be capable of forming into sheathing at a temperature which will not damage the insulating material of the cables, which is, in the case of telephone cables, paper. Lead is the only common and cheap material which meets these requirements and it appears that so long as we adhere to paper insulation and the seamless tube type of sheathing, we will be restricted to lead or its alloys for cable sheath.

The sheath in service requires resistance to corrosion and to failure from fatigue and tensile stresses.

The failure from intercrystalline corrosion has been very widely studied. Failure from this cause in practice has, however, doubtless been greatly overrated since fatigue failures have a very similar appearance.

It has been generally observed that the presence of a small amount of a second element in solid solution in the lead prevents intercrystalline breakdown from corrosion alone even under drastic treatment with lead acetate and nitric acid (Rawdon's reagent[1]). Lead-antimony and lead-tin alloys are accordingly free from this type of corrosion.

Other types of corrosion are of importance in special cases, but it appears the failure of cable sheath from simple corrosion is a rather rare case.

Practically all the high lead alloys then, with the definite exception of magnesium alloy, are suitable for cable sheath from a corrosion standpoint and we have to concern ourselves principally with the mechanical properties, which affect extrudability and durability in service.

In selecting mechanical properties it is necessary to compromise between pliability and high strength. A study of installation and service conditions leads to a tensile value of around 4000 lbs./in.^{2} as the most desirable value. This strength should, of course, be accompanied by the maximum possible fatigue limit.

> Note: In lead alloys the rate of stress application is very important in all cases where all tensile strength is mentioned without other qualifications. A rate of 1″ per min. in the movement of the tensile machine head is understood. The elongation has not been considered of great significance in this investigation, since practically all cable sheath alloys elongate over 30% when pulled at this rate.

The Lead-Antimony Alloys as Cable Sheathing

The 1% antimony alloy in use by the Bell System has been shown by investigations in this laboratory to be a solid solution at the temperature of extrusion (about 250° C.). This solid solution breaks down at room temperature, giving the antimony dispersed through the lead in the form of fine particles. Such a structure is known to be stronger and harder than either the solid solution or more coarse aggregate of the two metals. This dispersion hardening for the system lead–antimony has been fully discussed in a paper by Dean, Zickrick and Nix.[2]

As a consequence of this dispersion hardening process, 1% antimony alloy as extruded increases slowly in strength at atmospheric temperatures for more than a year, increasing in some instances from 3000 to more than 4000 lbs./in.^{2} or more, and then gradually decreases. This increase in strength is accompanied by a decrease in elongation. By increasing the antimony content, the tensile strength reached may be increased and also to some extent the rate of reaching it. Another factor now enters, however, which precludes the possibility of obtaining an appreciably better cable sheath in this way. This is the accelerating action of cold work on the agglomeration of the antimony particles.

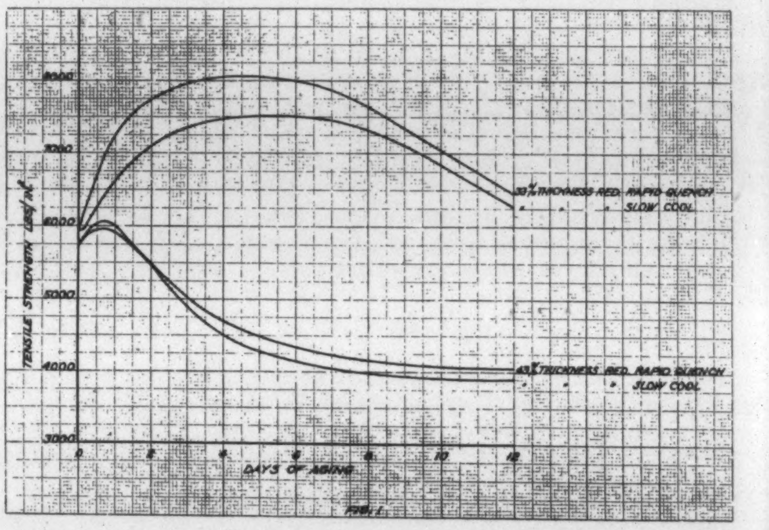


Fig. 1

This effect of cold work on decrease of tensile strength is shown in Fig. 1 for a 2% Sb alloy. In this case the working was accomplished by rolling immediately after quenching. With no work the alloy would have continued to harden for months. Similar increases in the rate of reaching equilibrium by means of cold work were observed by Schumacher and Bouton.[3]

This agglomeration due to cold working may also be easily observed in 1% antimony cables in service. Figs. 2 and 3 show micro-sections of a lead-antimony cable which failed in service presumably from fatigue stresses. Fig. 2 was prepared by the method of polishing and etching as described by Rutherford[4], and Fig. 3 was prepared by the microtome

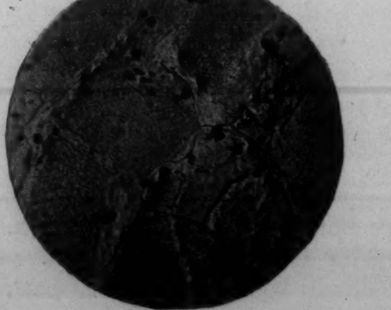


Fig. 2—× 100. (Reduced 60%.)

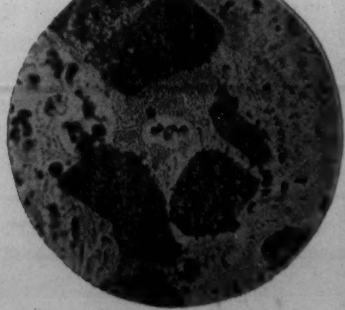


Fig. 3—× 100. (Reduced 60%.)

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* Metallurgical Division, Western Electric Company, Inc.

[1] H. S. Rawdon, *Proceedings American Society for Testing Materials*, **18**, Pt. II, 189–200 (1918).

[2] R. S. Dean, L. Zickrick and F. C. Nix, "The Lead–Antimony System and Hardening of Lead Alloys," *Transactions American Institute of Mining & Metallurgical Engineers*, **73**, 505 (1926).

[3] E. E. Schumacher and Geo. M. Bouton, *Journal American Chemical Society*, **49**, 1667–75 (1927).

[4] Rutherford, *Proceedings American Society for Testing Materials*, **24**, 739 (1922).

method described by Lucas[5]. Both photomicrographs show the agglomeration of the antimony particles in the grain boundary area, leaving zones of nearly pure lead. The greater detail obtainable by the microtome method shows clearly the building up of the larger antimony particles by accretion from the surrounding smaller ones, leaving "halos" of nearly pure lead around the larger particles. Fig. 4 shows a single large particle which, from the direction of the cleavages, can readily be identified as antimony. These photomicrographs were made by Mr. E. F. Salchow of this organization.

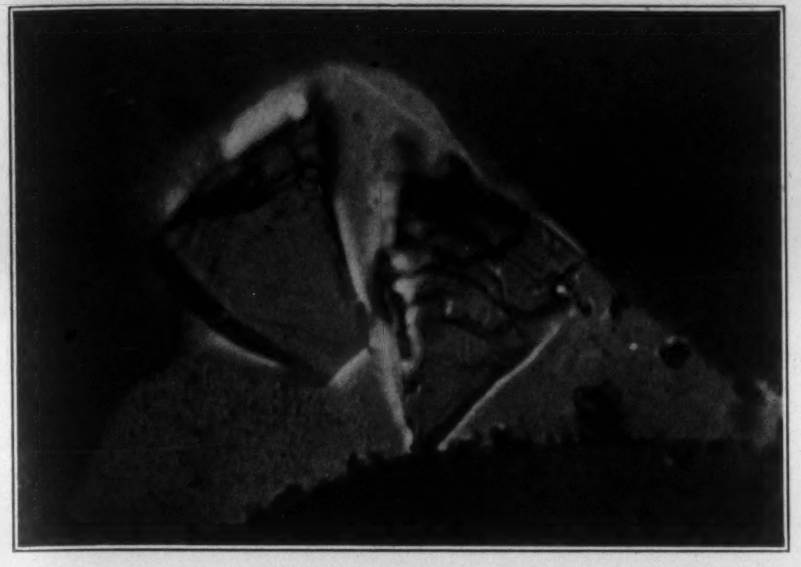

Fig. 4—Quenched, Aged and Reheated 2% Lead-Antimony Alloy. × 2000. (Reduced 50%.)

It, therefore, appears that since all cable sheath is necessarily subjected to some stress, there is no greater improvement in cable sheathing possible in the direction of lead-antimony.

The best outlook for cable sheath improvement then seems to be to find a dispersion hardening lead alloy which will not agglomerate under service conditions. The first direction in which to look for this is to add something to the lead-antimony alloys which will stabilize them. A great amount of work has been done along this line and some stabilization obtained with a number of added constituents. Perhaps the best of these is arsenic, the effect of which has been described by Seljesaeter[6]. Large amounts of cadmium are also effective and Beckinsale and Waterhouse[7] have described cable sheath materials of 0.5% antimony and 0.25% cadmium. These alloys, however, show agglomeration at the grain boundaries exactly as do the simple lead-antimony alloys. Figs. 23 and 25 show a lead-antimony-cadmium alloy broken by fatigue stresses.

Lead-Calcium Alloys as Cable Sheath

The investigation then turned to other alloys than those of lead and antimony and of those investigated the best properties were found in lead-calcium alloys which had been discovered to possess dispersion hardening properties in the alloys below 0.1% calcium.

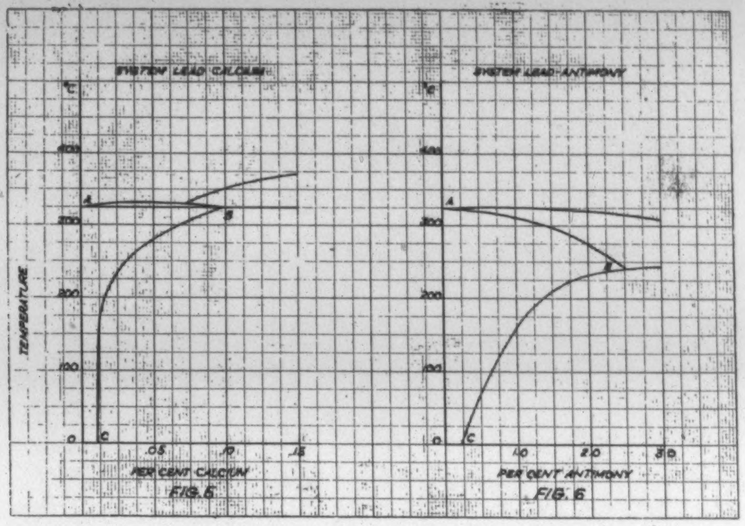

Fig. 5 Fig. 6

The lead–calcium system was found to be in many respects similar to the lead-antimony system. The equilibrium diagrams as determined from thermal analysis, microstructure and electrical conductivity for the two systems in the respective ranges considered, are shown in Figs. 5 and 6. (The lead-calcium diagram is taken from the paper of Schumacher and Bouton.) In both cases the most desirable alloys from the standpoint of cable construction fall within the composition limits of the solid solution field, ABC. If alloys within this range are cooled very slowly, we obtain a mixture of saturated solution at room temperature "C" with the excess constituent in microscopically visible particles. In the case of lead-antimony, this excess constituent is, as already pointed out, antimony, while in the case of lead-calcium, it is the compound Pb_3Ca.

Figs. 7 and 8 show alloys of 0.08% calcium and 1% antimony, respectively, which have been cooled very slowly from 250° C. in the case of lead-antimony, and 280–300° C. in the case of lead-calcium. Now, if these same alloys are quenched from these temperatures instead of cooled slowly, the solid solution is preserved at room temperature. These alloys are microscopically homogeneous, as shown in Figs. 9 and 10. These super-saturated solid solution alloys are somewhat softer than the corresponding slowly cooled alloys, but on standing a constituent separates in a very finely divided form and the alloy increases in strength. In the case of the lead-antimony alloy, this separating constituent quickly grows to the size of microscopic visibility, while in the case

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[5] F. F. Lucas, *American Institute of Mining & Metallurgical Engineers*, **1927**, 1654-E, 15 pages.

[6] K. S. Seljesater, *Technical Publication* No. 179, *American Institute of Mining & Metallurgical Engineers.*

[7] S. Beckinsale and H. Waterhouse, *Engineering*, **125**, 299–300, 334–336 (1928).

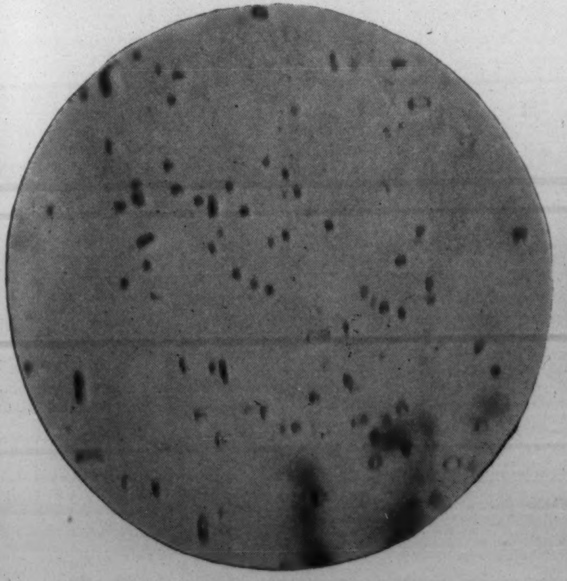

Fig. 7—× 2000. (Reduced 64½%.)

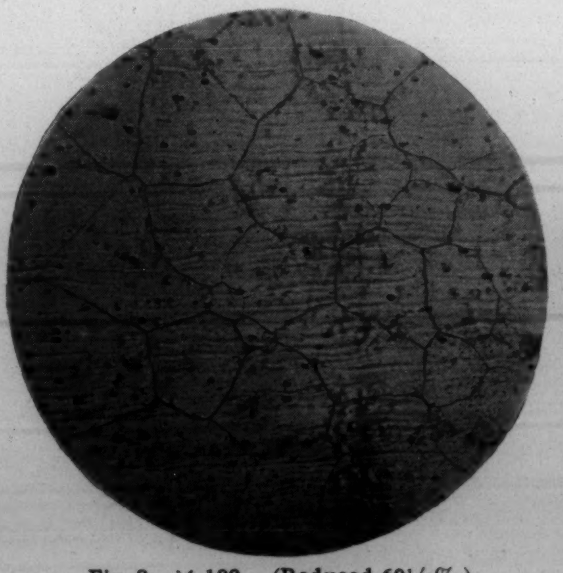

Fig. 8—× 100. (Reduced 69½%.)

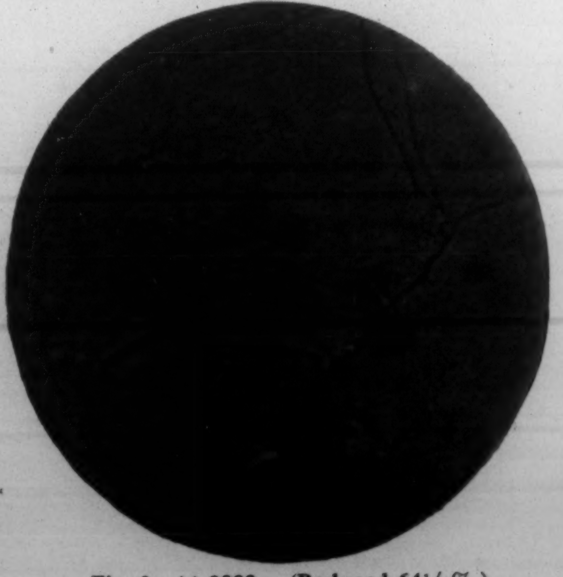

Fig. 9—× 2000. (Reduced 64½%.)

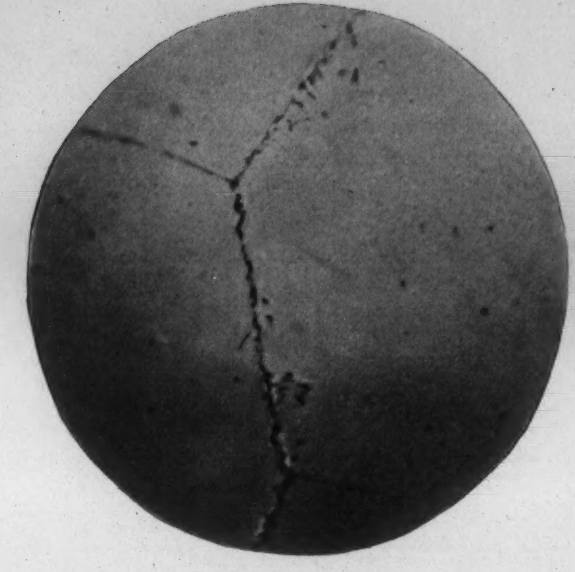

Fig. 10—× 1000. (Reduced 64½%.)

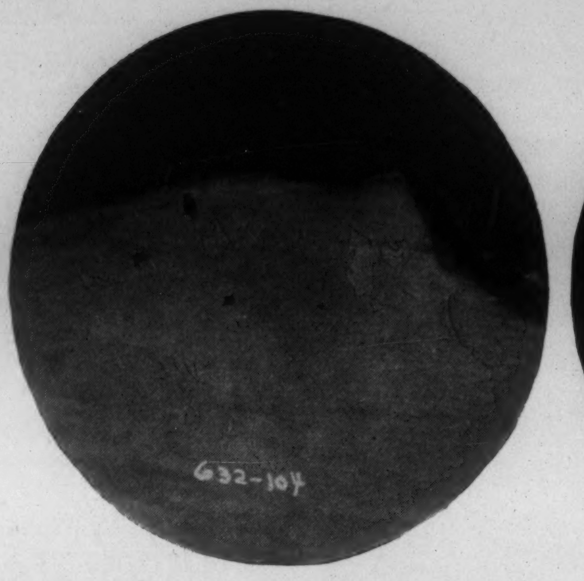

Fig. 11—× 100. (Reduced 64½%.)

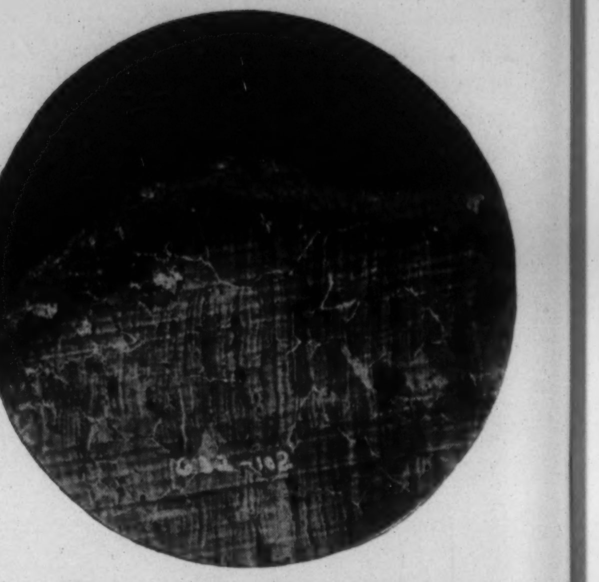

Fig. 12—× 100. (Reduced 64½%.)

of lead-calcium the particles do not reach the size of microscopic visibility after long standing at room temperature or indeed even after one week at a temperature of 150° C.

This reluctance of the particles of Pb_3Ca to grow extends even to the action of cold work and we have been unable to produce agglomeration of the particles to visible size even by this means. Figs. 11 and 12 show an 0.08% lead-calcium alloy and a 1% lead-antimony alloy subjected to the same conditions of fatigue to produce failure. It will be seen that agglomeration has taken place in the lead-antimony but not in the lead-calcium. (Photomicrographs taken by Mr. R. O. Day, using the microtome method of preparation.)

The lead-calcium alloy then has basically the properties desired in a cable sheath alloy and it remains to be determined what composition and treatment of this alloy will produce the most satisfactory cable sheath.

Physical Properties of Lead-Calcium Alloys of Various Compositions and Heat Treatments

The number of variables affecting the physical properties of dispersion hardenable alloys is large and it was, therefore, desirable to make a cursory survey of the field to determine the most desirable alloy. This survey is summarized in the following series of curves.

Effect of % Calcium and Aging Temperature on Tensile Strength

Fig. 13. These curves show the effect of percent of calcium on the hardness obtained after aging at room temperature, 100 and 150°. The aging at these various temperatures was carried on until practically constant values were reached. It will be seen that strengths varying from 2000–7000 lbs./in.² can be obtained, the optimum temperature being near 100° C.

Effect of % Calcium and Quenching Temperature on Tensile Strength

Fig. 14. This curve shows the effect of various quenching temperatures. It will be noted that the higher calcium alloys require higher quenching temperature to show their full hardening effect. This would be expected from the solubility curve. From this curve it appears that the desired tensile strength of about 4000 lbs./in.² can be obtained with any alloy above 0.03% by control of extrusion temperature. However, the range of 0.03–0.04% gives the widest range of extrusion temperatures from which cooling will give strengths close to 4000 lbs. and this composition would, therefore, be desirable from a manufacturing standpoint. It will, however, be necessary to further examine the properties of these various alloys having the desired strength, particularly the fatigue properties. For this purpose we have used a static "fatigue" test which will be described in more detail in a later paragraph. The results of the comparison of high and low calcium alloys by this means are shown in the following table:

	Rockwell	Calc. T. S.	Load lb./in.²	Hours to Break
0.065% Ca 0.033% Ca	68	4500	1200	117 120,000
0.065% Ca 0.028% Ca	57	3800	1330	8 3,200

It, therefore, appears that the higher calcium alloys treated so as to give strengths around 4000 lbs. possess in a marked degree the property of flow under low stresses and are, therefore, unsuitable for cable sheath. The best outlook for a good cable sheath alloy is accordingly the 0.03–0.04% calcium alloy cooled from 225–250° C.

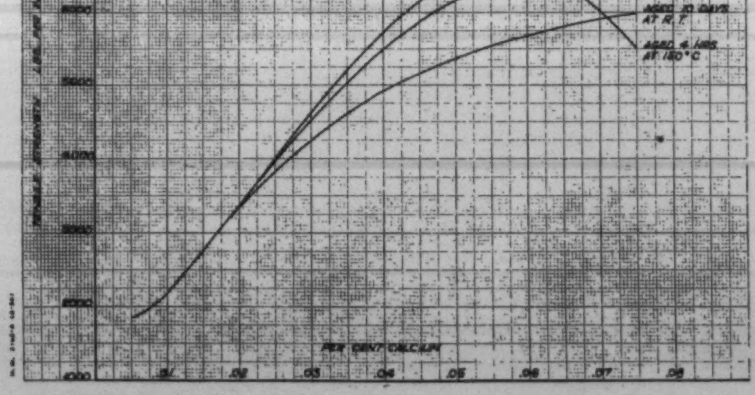

Fig. 13

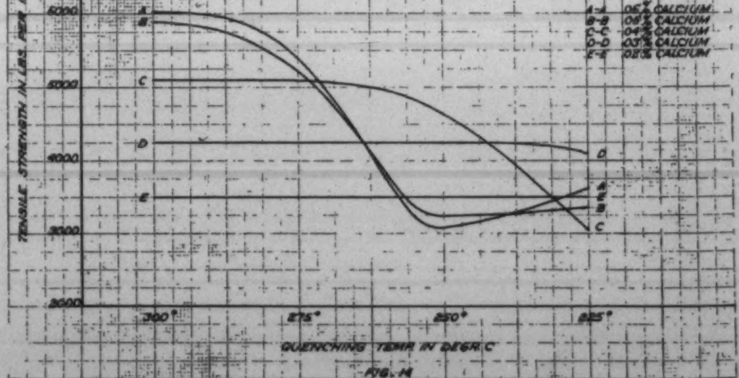

Fig. 14

Commercial Preparation of 0.03–0.04% Lead-Calcium Sheath and Its Properties as Compared to Other Sheaths

Preparation of the Alloy

The lead-calcium alloys under consideration for cable sheath are commercially most conveniently prepared by diluting an intermediate alloy containing a higher percent calcium with lead. A 1% calcium alloy dissolves readily in molten lead at 700° F. and is, therefore, adopted as the most suitable for this purpose. To prevent excessive loss of calcium by oxidation, the molten lead is covered with charcoal before the intermediate lead-calcium is added, which cover is maintained on the molten alloy.

The preparation of the 1% alloy mentioned above and other higher percentage calcium alloys are commercially accomplished by electrolysis of fused calcium chloride with a carbon anode and molten lead as cathode.

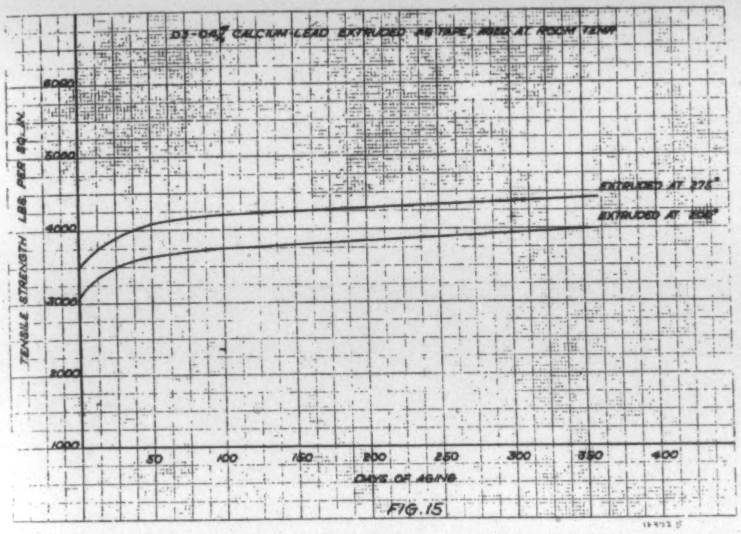

Fig 15

Limits of Extrusion Temperature

Fig. 15 shows the tensile strength of 0.03–0.04% lead-calcium alloy extruded at 200° C. and at 275° C. It will be seen that even with these wide limits the tensile strength range after one year is 4000–4400 lbs. The extrusion temperature is, therefore, not critical. The higher temperature range 225–250° C. is, however, desirable in that the final tensile strength is more quickly reached.

Fatigue Limits of Cable Sheathing

Dynamic Fatigue

For the determination of dynamic fatigue we have used the type of machine designed by H. F. Moore for flat specimens. These machines operate at 1700 reversals per minute and give apparent fatigue limits on the lead-antimony and lead-calcium cable sheaths. The curves in Fig. 16 show typical experimental results. The average of a large number of tests in each case give the following values for the fatigue limits of the three types of sheath tried.

Alloy	Tensile Strength lbs./in.²	Fatigue Limit lbs./in.²
1% Sb-Pb	3200	900–1000
Pb-Sb-Cd	3400	1000
0.04% Ca-Pb	3800–4500	1200–1500

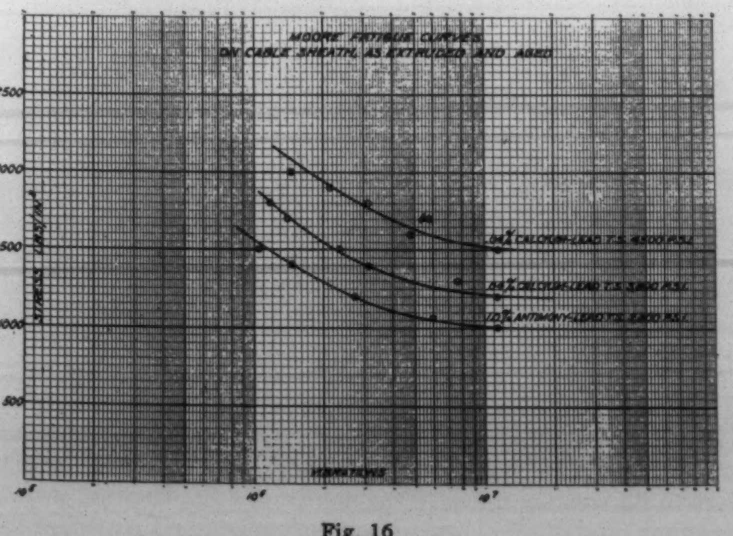

Fig. 16

Static "Fatigue" Tests

These tests consisted simply in determining the length of time necessary to break a tensile sample of lead alloy with various loads, all less than the tensile strength as determined by applying the load in a tensile machine. The arrangement of the set-up is shown in photograph Fig. 17. The results of these tests are shown in Fig. 18. There are several ways of interpreting these curves but since they are approximately parallel lines as plotted on semi-logarithmic paper, we may conclude that with a given load the lead-calcium alloy sheath would last from 10–100 times as long as the lead-antimony sheath.

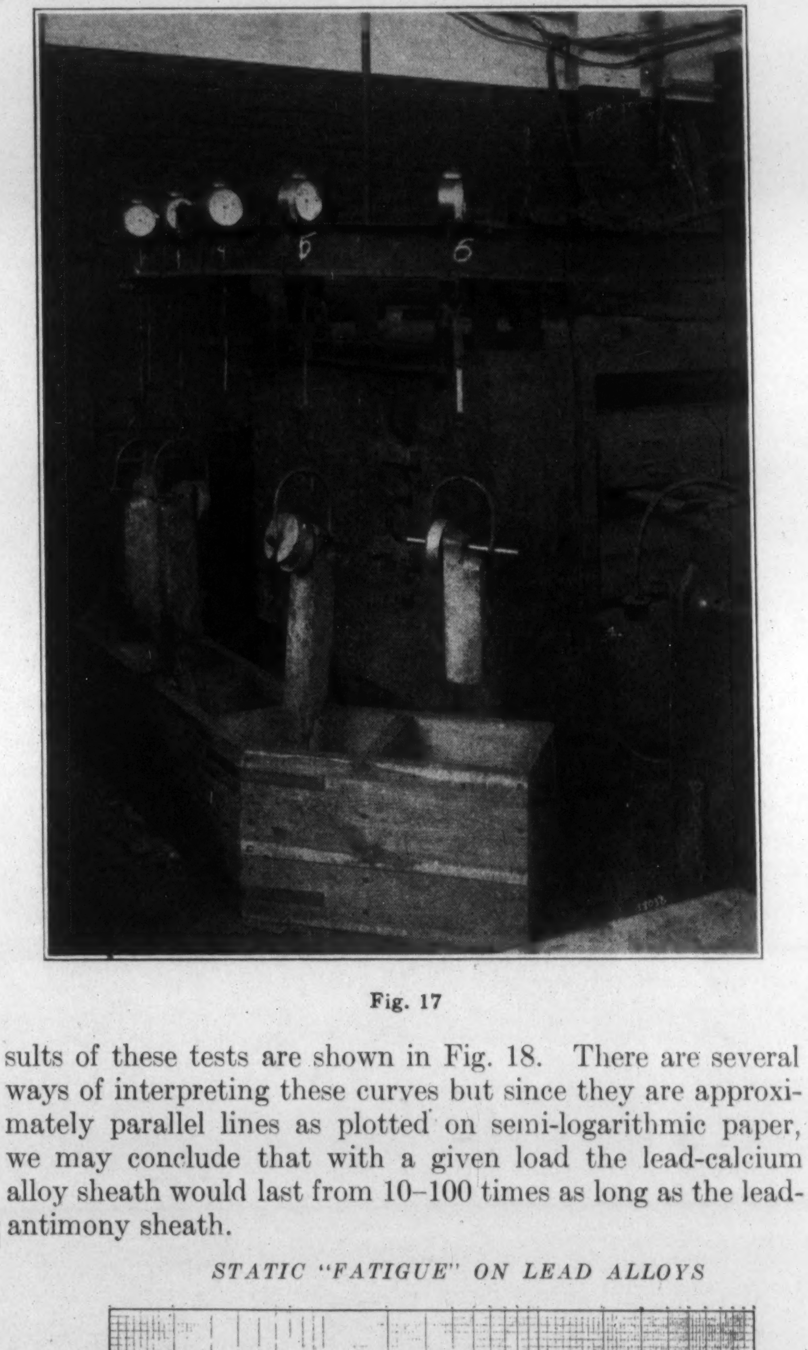

Fig. 17

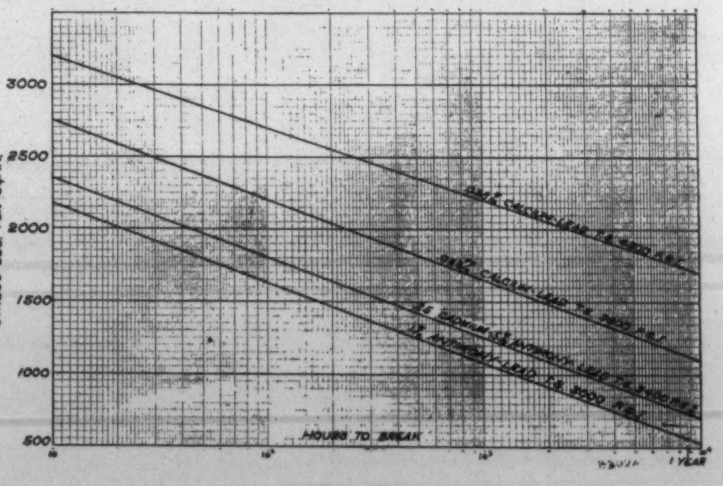
STATIC "FATIGUE" ON LEAD ALLOYS

Fig. 18

Structure of Fatigue Failures

Failure obtained by static "fatigue" under small loads is an intercrystalline failure like that obtained in service. Fig. 19 shows a static "fatigue" break on lead-calcium sheath. The microstructure of fatigue breaks of the several alloys, both "static" and dynamic, are shown in Figs. 19–25. The definite breakdown of the structure in all the alloys, except lead-calcium, is easily apparent.

Conclusion

The lead-calcium alloy containing 0.03–0.04% calcium and cooled from an extrusion temperature of 225–250° C. has a tensile strength of about 4000 lbs./in.^{2}, a dynamic strength of 1200–1500 lbs./in.^{2} as determined on the Moore machine at 1700 r. p. m., and a static "fatigue" strength markedly superior to the 1% antimony alloy. These properties make this alloy a superior cable sheathing.

Acknowledgment

This work has been carried out over a number of years and several investigators have made important contributions to its success. Among these we wish to thank especially Mr. E. J. Quinn, Mr. R. A. Morgen, Miss E. H. Roberts and Mr. J. L. Gregg.

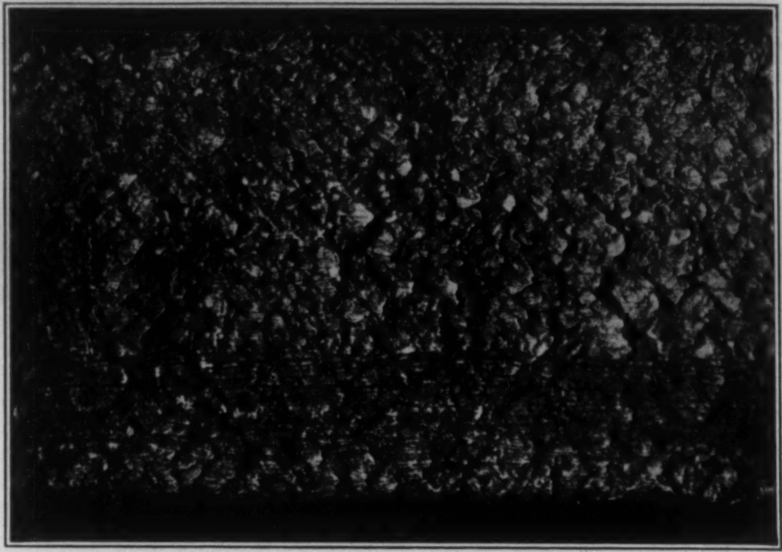

Fig. 19—0.025% Ca-Pb Broken in Static "Fatigue" Test. 1500 Lbs./In.^{2} for 100 Days. 58% Elongation in 2 Inches. ×10. (Reduced 50%.)

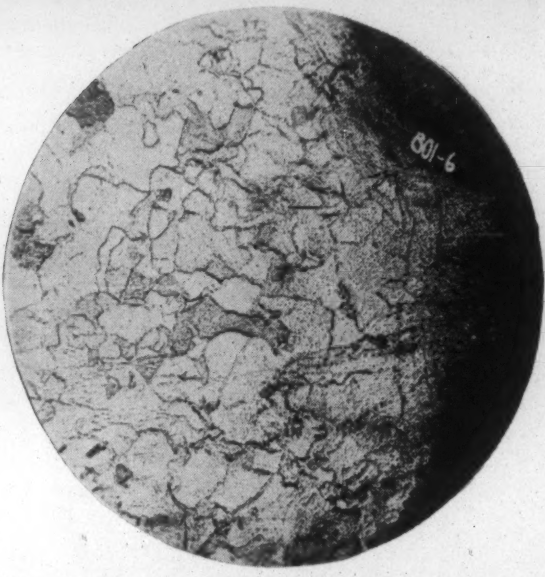

Fig. 20—0.038% Ca-Pb. "Dynamic Fatigue" Test. × 100. (Reduced 64$^1/_2$%.)

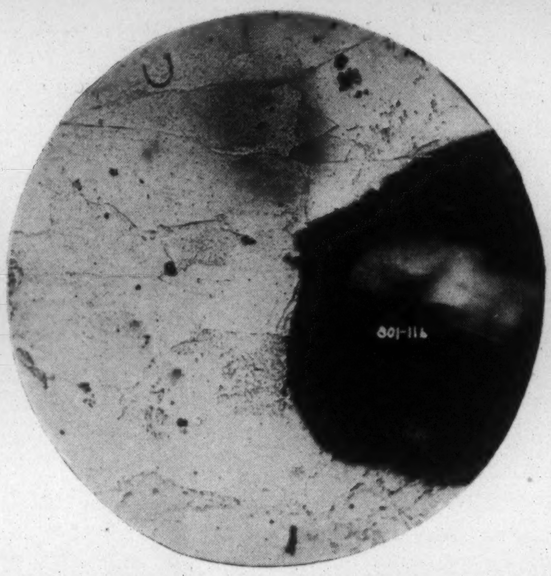

Fig. 21—0.038% Ca-Pb. Static "Fatigue" Test. × 100. (Reduced 64$^1/_2$%.)

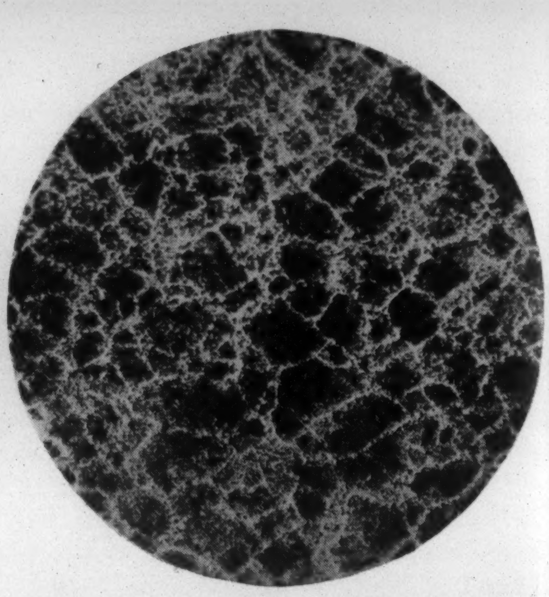

Fig. 22—1% Sb-Ph. Specimen Broken in "Dynamic Fatigue" Test. × 100. (Reduced 64$^1/_2$%.)

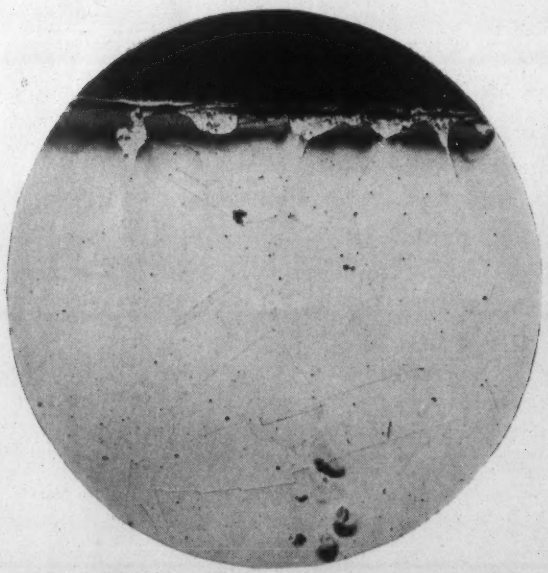

Fig. 23—Pb-Sb-Cd Specimen Broken in "Dynamic Fatigue" Test. × 100. (Reduced 64$^1/_2$%.)

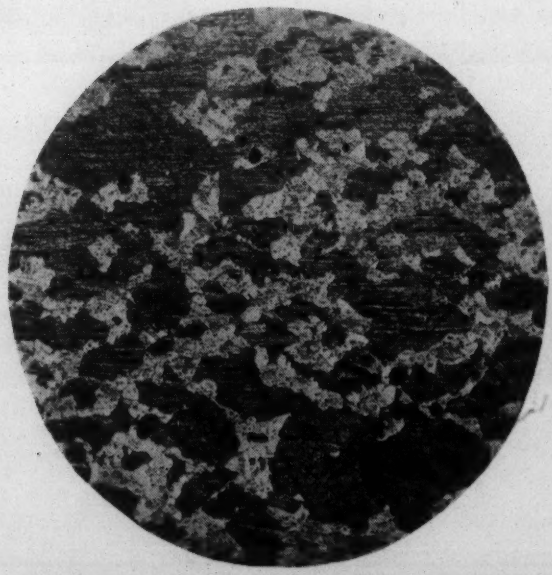

Fig. 24—1% Sb-Pb Specimen Broken in Static "Fatigue" Test. × 100. (Reduced 64$^1/_2$%.)

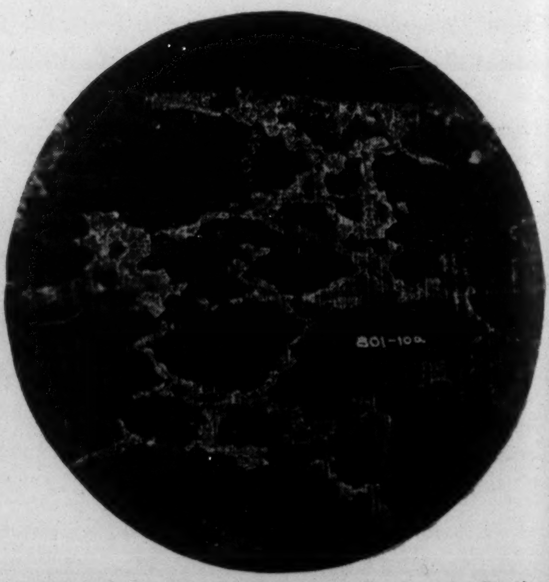

Fig. 25—Pb-Sb-Cd Specimen Broken in Static "Fatigue" Test. × 100. (Reduced 64^1/%.)

F. W. Maclennan has been designated by the President as official delegate of the Society to the Third (Triennial) Empire Mining and Metallurgical Congress to be held in South Africa this year.

Col. H. H. Stout has resigned as consulting metallurgist of the Phelps Dodge Corporation to go into independent consulting work. He will be retained by the Phelps Dodge in a consulting capacity.

At a recent meeting of the board of directors of The Connersville Blower Company, Inc., John T. Wilkin, president and chief engineer, was chosen as general manager, also. At the same time, Bernard C. O'Brien, formerly in charge of sales in Pittsburgh, was elected secretary; W. E. Newkirk, purchasing agent, became treasurer and E. C. Hassler, assistant superintendent, was appointed acting superintendent. The last three selections were to fill vacancies due to the deaths of J. E. Huston, secretary-treasurer, and R. T. Huston, vice-president and superintendent.

Research Precision vs. Pedigree Steel

By G. M. Eaton*

The commercial evaluation of steel is based upon certain physical characteristics, which the purchaser is justified in believing will be met by *all of the steel* of a given type designation, which he may use.

If he is correct in this belief, it is obvious that either,

1. All of the steel is of uniform quality, or,
2. The specified characteristics are graded down to a point sufficiently low to cover the poorest portion of the steel that is actually sold.

We know very well that the second alternative is the one which prevails. Yet there is in progress to-day a very impressive amount of research which is directed toward attaining a closer degree of accuracy in defining the quality of steel. Practically all of the reports of this work which have come to our attention, with the single exception of that having to do with railroad rail steel, deal with the steel by type designation alone, and disregard the location in the ingot from which the material actually tested was taken. There is a marked tendency in this research work to adopt methods of increasing refinement, with the underlying thought that this procedure will reduce the Ignorance Content in the Factor of Safety.

We are heartily in favor of making continual improvements in research methods.

But we advocate even more strongly the practice of taking periodic bird's eye views of the broader aspects of all research problems, in order to be sure, before spending time and money for facilities of increased precision, that these facilities are not aimed at evaluating variables of an order lower than other variables which affect the results and which are present in the material undergoing test.

When this periodic review develops the fact that we are straining at a gnat while calmly swallowing a camel, it is time to clamp the lid down tightly on appropriations, until we are assured that the uniformity of the test material has reached a point which will justify its closer scrutiny. If we fail to do this we are in serious danger of deriving information supposed to be fundamental but which is unfortunately untrue.

We have read recently a number of reports of research in the ferrous field which lead us to the conviction that the discrepancy in the order of variables as referred to above did exist in a marked degree. It does not seem constructive to make specific reference here to the particular researches which we have in mind, as they were undertaken in good faith and some very clever detail work was done. But the unfortunate fact remains that information purporting to approach fundamental value is being published.

Yet it is highly probable that the findings are some of them nothing more than the characteristics of the individual pieces which were tested.

So much for what may appear at casual reading to be simply destructive criticism.

Probably we will always find variations in steel, and the general degree of these variations will determine the sensible refinement of research procedure. Fortunately it is possible to squeeze out some of these variations in steel submitted for research tests, and to do this in a practical manner which can be the basis of improved commercial application of steel in industry.

Reference has been made to railroad rail steel. It is the universal practice in the United States to roll into every rail a clear designation of its location in the ingot. This information is used in following the life history of rails and a tremendous volume of information has been accumulated bearing on the relative merits of rails coming from the various zones of the ingot.

While it would be eminently unfair to draw a close comparison between the standard open-top-big-end-down rail ingot and the hot-top ingot used for high quality steel, the sad fact remains that there are more or less well recognized regions of inferiority in most ingots. With this fact staring us in the face it is fatuous to inject more than a reasonably comparable degree of refinement into the methods for the evaluation of a particular characteristic of a given steel. If we are now working within the limits of a sensible balance between methods and uniformity, we have no right to refine our methods, if this refinement costs appreciable money, until such time as we are willing to go beyond the type designation of the steel and consider the ingot location of our test material.

We are not going to attempt here to enter a discussion of the relative quality of the various zones of ingots. We will simply repeat that in certain steels and ingots characteristic local inferiorities recur with discouraging persistence. Steel mill men who have made a life study of ingots can tell us in advance with a surprisingly close degree of accuracy, just where Vee cracks will appear in a given split and etched ingot section. This is only one of many ingot characteristics, but it will serve as sufficient illustration of the point we wish to emphasize.

Let us see what it would mean if in steel adapted to services of vital importance, and where service failure involves hazard to human life, every bar of steel was stamped with its ingot location. During the earlier stages of this practice of furnishing "Pedigree Steel," large users who were able and willing to purchase the product of entire ingots, could capitalize on the practice rather better than could the users of small quantities of steel. The research departments both of the large user and the steel mill would promptly attack the problem of the evaluation of the relative quality of steel coming from the various zones of the ingot. Having located the most superior zone the user would apply the best steel of the ingot to the most vital service and would degrade the inferior portions to service where these portions would be good enough.

More general publication of relative quality information would gradually follow, permitting the small user to apply his steel more intelligently.

The improved degree of uniformity which is actually found in the various ingot zones will then dictate the degree of refinement in research procedure, which can go hand in hand with common sense.

Stepping outside the realm of research and entering the field of the commercial production and application of steel in Industry, we find that both attractive and unattractive features are encountered in the practical adoption of the practice of stamping the ingot location on every bar of selected steel mill products.

We may as well face the difficulties first, and give them close attention so that we may form a firm opinion as to whether or not they are anything more than Stone Lions in our path.

Starting first in the steel mill, the problem of keeping track of ingot location for the highest grades of steel, is very much more complicated than the task as it exists in the rail mills.

In the rail mill the ingots and billets go easily and naturally through a simple and direct cycle, from the pouring of the ingots to the arrival of the finished rails at the marker rolls. Of course the reason for the simplicity of the cycle lies in the fact that the rail mill is designed around this cycle as one of the fundamental requirements.

In sharp contrast with this practically automatic rail mill cycle, we encounter in the case of the high grade steels the fact that the rolling cycle must be interrupted at the billet stage. The billets are allowed to become cold and are then inspected for surface defects which must be chipped out. The number of pickling and chipping operations which are required to finally achieve a satisfactory surface condition varies widely on successive billets from the same ingot, and from ingot to ingot, etc.

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* Molybdenum Corporation of America.

This means that what we may term the segregation of the billets made from each ingot and their orderly passage through the finishing rolls, involves increased time and labor, with attendant increase in cost, as well as increased opportunity for error, particularly when production is heavy. For example, if after a given billet has been pickled and chipped several times, the decision is reached that this billet should be condemned, then at the marker rolls an arrangement has to be set up where this billet number will be skipped in marking the finished stock as it comes through.

To carry out this segregation efficiently it is entirely possible that some rearrangement of the chipping aisle would be advisable. At present we can see possible justification for this segregation, only on certain types of steel, and perhaps at the start of the practice, only on such portion of the production of these types as may be applied on orders where segregation is specified. It may then happen that the chipping aisle arrangement best adapted for billet segregation is not the most advantageous for the present practice. This might dictate a separate chipping aisle section for the segregated billets.

A possible further effect on the steel mill may lie in the difficulty of selling the inferior portions of the segregated steel. This effect on the steel mill would be practically eliminated in the cases where, as suggested, large users purchase the product of entire ingots. But with the growth of the practice, when small users lean strongly toward the best material, the difficulty may become real. Price adjustments seem to be the logical controlling factor.

Pedigree Steel is well worth while, and should be used in many vital applications. But the appetite for it must not be built up on any false basis, and it is justifiable only when a cold analysis of all the contributing factors shows a cash balance on the proper side of the ledger. In making this analysis the steel mill problem must be considered in a thorough manner.

Looking now at the problem confronting the user of large tonnages of Pedigree Steel, and who purchases the product of whole ingots, we must expect that the difficulty of applying the inferior portions of the ingot will constitute a real problem. The entire ingot we will assume has been purchased at a flat price per pound. We will also assume that this large user employs a number of engineers who will wish to use this steel in the machines for which they are responsible. Then we may rest absolutely assured that each individual engineer will demand the best zone of the ingot for his product, and will advance the most cogent arguments to back up this demand. Here again, the obvious corrective measure is the setting up within the users, organization of a sliding scale of cost of material originating in the various zones of the ingot.

If we had been guilty of trying to make a high pressure sale of the Pedigree Steel idea we would doubtless have soft pedalled on the difficulties. Let us remember that we are discussing the relation between refinements of research methods and the variations existent in steel designated by type number. We are calling attention to the limits to which we may sensibly go in the precision of method, and are showing that there are available ways of reducing some of the variations in steel as presented for research analysis. We are then stepping into the practical conditions encountered in availing ourselves of these reductions of variation. The presentation of some of the outstanding difficulties first, is the logical engineering approach. The man who is discouraged by difficulties never made much of a splash in the industrial or research puddles.

Now let us pass to the bright side of the picture.

In following our present practice of evaluating steel by Type designation alone, we are shrinking from a frank facing of the issue. In spite of the notable advance now in the process of evolution in the United States along the line of applying to difficult engineering problems the activities of men skilled in the use of higher mathematics mechanics, elasticity, plasticity, etc., there remains an overwhelming array of unknown variables that may produce wide discrepancies between the vision in the mind of the designer and the actual service performance of his machine.

The only course that can be followed in such cases is found in constructing the best machine that existing knowledge will permit. This machine is then tested and put to work. The adequacy of the design is judged by the service which it achieves. The most unfortunate situation that can arise is perhaps the apparently good luck of incorporating in the vital parts of the first machine, material that is the very best of the Type of steel employed. A decision is made to go into some degree of production of the machine. Sooner or later the vital parts are built with steel that is of the lowest grade of the type. This may narrow the factor of safety to the point of unsatisfactory performance or actual failure. This is probably an extreme illustration, and yet it is fair.

The demands of industry to-day bring tremendous pressure to bear on the design engineer to skirt closer and closer to the edge of danger. Whatever our opinion of the propriety of this pressure, we may as well face the fact that it is applied and that in a degree that will continue to increase. The design engineer naturally and properly hands this pressure over, with all the urge that he can add, to the research engineer, with a demand for closer knowledge of the basic characteristics of his materials of construction. The research engineer who yields to this pressure to the extent of passing the limits of common sense in the precision of his work is a weakling. The two types of engineer must join forces to insist that all possible variations be eliminated from their materials as soon as the pressure under which they jointly labor reaches the stage which justifies this demand. The steel mill which has the vision and the courage to meet this demand for Pedigree Steel, will be rendering a real service to the particular industry involved. Business to-day is based upon service and our forward looking steel mill thus grasps a new tool for building up their quality trade.

The user of Pedigree Steel can establish new limiting conditions within which he can build bigger, better and maybe in the last analysis cheaper machines. It may seem out of place to include cheaper machines in this category. But there are real possibilities along this line. For example the best of Type B steel may be well ahead of the poorest of Type A steel, though we now rate the average of Type A well above that of Type B. Then, too, the proper rating of the relative cost of two machines is a composite of many functions, which must inevitably include a weighing of the cost per unit production achieved by the machine in its service. This type of cost analysis, of course, often shows that the detail cost of certain vital parts is completely overwhelmed by other factors in the final accounting.

We arrive at the final conclusion that when industrial pressure forces the design engineer up against what appears to be fundamental limits resident in his materials of construction, it may well occur that instead of seeking closer evaluation of his materials as they now exist commercially, his plain duty is to exert his full influence toward securing a commercial supply of material which is worthy of closer evaluation.

The research engineer must join hands with the designer in this pressure for improved material and must courageously resist pressure to lavish on variable material more than a thoroughly practical degree of precision of research method.

Since of all our materials of construction the outstanding position is held by steel, the demand for Pedigree Steel is with us now. Once started as an available material natural evolution will allocate to Pedigree Steel its proper place in industry.

The Flow of Metal in Molds*

With Special Reference to the Behavior of Gray Cast Iron

By George M. Enos[1]

Changes of State in Molds

In the pouring and solidification of gray cast iron in sand molds certain changes of state take place, which are of interest since lack of control of the rate of change will be likely to cause defective castings. Specifically these changes are:

1. Liquid water in the sand to steam.
2. Organic materials burned to gases.
3. Molten cast iron to solid.
4. Changes in the solid cast iron, for example, the liberation of graphite.

The changes of state from gas to liquid, and from liquid to solid, or changes in the reverse order, involve changes in heat content of the material. In Fig. 4 is plotted the changes of state for water, plotting time against temperature and considering pressure as constant. At temperatures below 32° F., the water is solid. If it is heated, at a temperature of 32° F., it will change from solid to liquid as heat is added but the temperature is not raised until the last particle of solid is melted. The heat required to bring about this change is called the latent heat of fusion. As heat is added, the temperature rises slowly during the time period used to bring the water from the freezing to the boiling point. At 212° F. another change of state takes place, liquid to vapor, again with absorption of heat, the heat required being called the latent heat of vaporization. On cooling the vapor, (steam), heat is evolved at 212° F. and again at 32° F.

Similar changes occur in iron except that as the vaporization change is at a very high temperature it is not ordinarily considered. In Fig. 5 an iron-carbon alloy cooling curve is shown. Above 2192° F. the alloy is completely liquid, between 2192 and 2075° F. the alloy is partly liquid and partly solid, and is entirely solid below 2075° F. Latent heats are indicated by arrest points on the curve, as in Fig. 7. It should be pointed out, however, that the temperature of the upper arrest point is determined by the carbon content. For reference, an iron-cementite diagram is given in Fig. 6. Although the metallography of cast iron will not be discussed in detail in this article, it may be well to recall that relationships between temperature and composition in binary alloys may be shown on phase diagrams of the type shown in Fig. 6. In dealing with alloys containing as many constituents as are commonly found in gray cast iron, viz. iron, carbon, silicon, manganese, phosphorus and sulphur, it is impossible to show on a single graph, the influences exerted on the melting point of the alloy by changes in the percentages of the various elements. In Fig. 7 an inverse rate cooling curve of a siliceous gray iron is shown. This was given by Stead[1] and the analysis was given as combined carbon, trace, graphite 3.3%, Mn 0.67%, Si 4.32%, S 0.025%, P 1.66%. From the diagrams it is evident that various changes occur in the solid state, dependent on the silicon percentage and other factors.

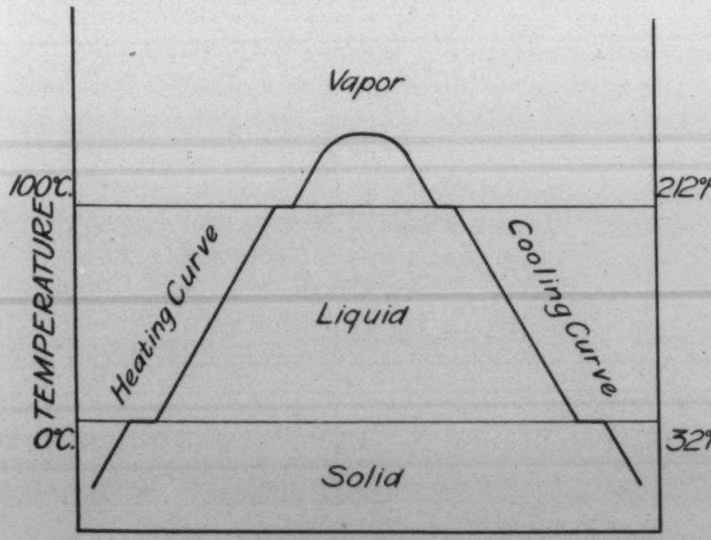

Fig. 4—Heating and Cooling Curves for Water

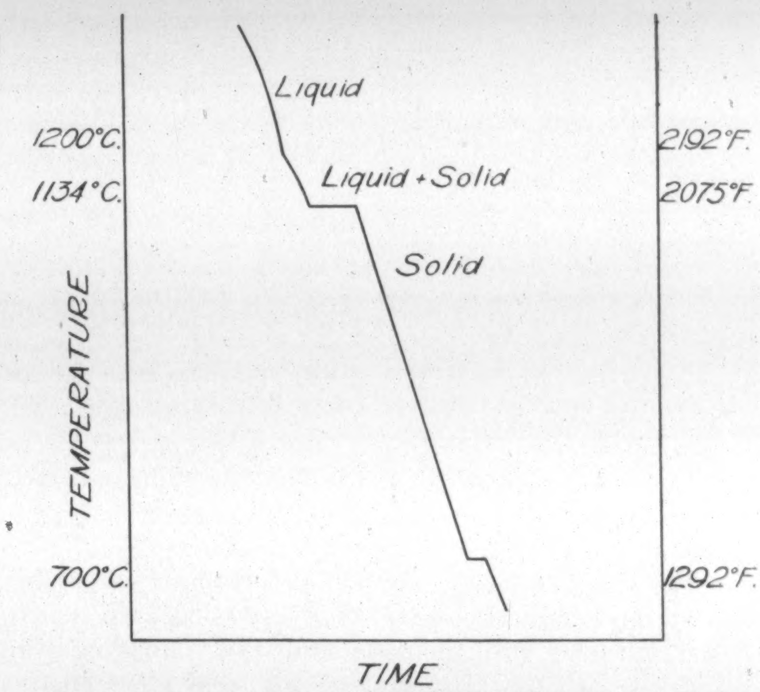

Fig. 5—Cooling Curve for an Iron-Carbon Alloy (a "Theoretical" Cast Iron) Containing 3.5% Carbon

Changes of State in a Mold

The changes which take place in a sand mold are of three general types. *First*, the liberation of steam and gases (1) from liquid (2) or solid materials (3); *Second*, the change from liquid to solid iron. *Third*, the changes in the constituents of the solid iron as it cools. All of these changes are of importance, and if not controlled may lead to serious defects, or to undesirable characteristics in the iron.

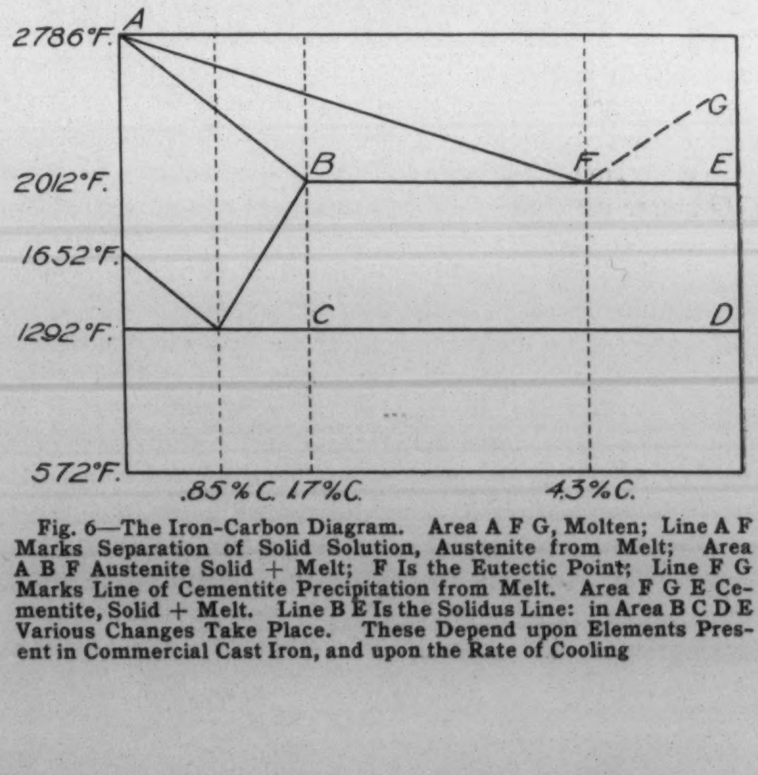

Fig. 6—The Iron-Carbon Diagram. Area A F G, Molten; Line A F Marks Separation of Solid Solution, Austenite from Melt; Area A B F Austenite Solid + Melt; F Is the Eutectic Point; Line F G Marks Line of Cementite Precipitation from Melt. Area F G E Cementite, Solid + Melt. Line B E Is the Solidus Line: in Area B C D E Various Changes Take Place. These Depend upon Elements Present in Commercial Cast Iron, and upon the Rate of Cooling

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* Concluding part of an article in two parts: for Part I see pages 362-364 of this publication, February.

[1] Assistant Professor of Metallurgy, University of Cincinnati.

[1] Quoted by W. H. Hatfield, "Cast Iron in the Light of Recent Research, page 45. Charles Griffin & Co., Limited, 2nd ed., 1918.

Referring first to the changes which will cause the formation of gases, it is found:

1. If any volatile material, such as sea coal has been added in the facing or finish, two things may happen when the iron is poured in the mold.

1. Characteristics of Gases

1. They have a low density.
2. They completely fill any vessel in which they are placed, exerting a pressure in all directions on the walls of the container.
3. They have no definite volume or definite surface.
4. Upon proper regulation of temperature and pressure they can be converted to the liquid state.

2. Characteristics of Liquids

1. A liquid possesses definite volume under given conditions, but not definite form.
2. The density of liquids is greater than that of gases because the molecules are closer together.
3. Liquids do not have rigidity of shape. A liquid is a fluid which does not expand to fill the vessel but remains in a collected mass, conforming to the shape of the container.
4. A liquid exerts a pressure on the walls of the containing vessel where it is in contact with the vessel. The molecules move with considerable velocity in all directions. Some of the molecules may escape from the surface of the liquid if there is space to do so, and establish a vapor in contact with the liquid, the vapor also exerting a pressure.

3. Characteristics of Solids

1. A solid has definite form and volume.
2. The molecules in a solid are relatively close together.
3. In general, the density of a solid is higher than that of a liquid.
4. The atoms of metals, and of all crystalline materials on solidifying, will arrange themselves into definite geometric patterns within the crystals.

(*a*) The gas generated by the burning or vaporization of the volatile material may act as a film or cushion and allow the metal to glide by, thus protecting the sand.

(*b*) The heat of the molten metal may decompose ("crack") the organic material, thus liberating carbon in a finely divided form onto the mold wall, thus "smoking" the mold. Such carbon will disappear, for it may be burned away later, or it may be absorbed by the iron.

In these cases the essential change of state is from solid to gas, without apparent liquefaction. The result sought and generally attained is to protect the sand walls from direct contact with the hot iron, by a film of such thickness that it will have no effect on the size of the casting. Graphite, acting as a lubricant on the mold wall is preferred by many as a final finish on the mold, because it is not likely to react to form a large volume of gas which might cause a "blow." When mineral facings are used such as soapstone or talc, they are supposed to give a smooth finish to the casting. In large sections the heat of the iron may decompose the mineral facing, and if it contains water, liberate steam.

2. The moisture of the sand will be partially or wholly converted into steam. At the high temperatures, not only will mechanically held water be converted into steam, but also any chemically held water that is near enough to the hot iron. Steam behaves like a gas and exerts considerable pressure if confined. Hence, for large sections it is customary to dry the mold before pouring in order to eliminate as much moisture as possible. In many cases venting is required, when the natural voids in the sand cannot be depended upon to give sufficient uninterrupted passage to the flow of the gases.

In a green sand mold the heat of the iron will dry the sand for a considerable distance back from the casting. Many defects in castings are caused by improper venting—the steam becomes pocketed in the mold cavity and exerts such a back pressure that the iron cannot fill the mold completely.

In this connection it must be remembered that the air in the mold cavity may also be compressed with the steam. Usually when risers are employed, the steam and air will be swept from the mold cavity without any trouble unless the risers are improperly placed.

The second change of state involved in the mold is the actual change in the metal from liquid to solid. In the case of gray iron castings this change is further complicated by volume changes due to the liberation of graphite, as will be discussed later. The sensible heat carried in by the molten metal, and the latent heat of solidification are available for vaporizing water and gasifying any organic materials which may be present, and may even bring about the fusion of the sand. This latter condition is, of course, undesirable. The molten metal completely fills the mold cavity, and the gates and risers, but as freezing occurs the metal shrinks. It is of utmost importance that the solidification take place in such a way that no shrinkage cavities are left in the casting proper.

The temperature where the change of state from liquid to solid occurs in a pure metal is known as the freezing point, and corresponds in temperature to the melting point. This temperature is a constant value for pure metals. The change from liquid to solid is always accompanied by an evolution of heat, corresponding in amount to the amount of heat absorbed when the metal was melted. (Note horizontal arrest point at 2075° F. on curve in Fig. 5.) In dealing with alloys we find that there is a range of temperature where the material is both liquid and solid. (See Fig. 6.) For example, cast iron of a certain composition may start to freeze at a temperature of 2200° F., and the solidification will not be complete until the temperature has fallen some 25 degrees. In other cast irons the range may be greater or less, depending on composition. In considering casting temperatures the freezing point should be taken as the temperature where the iron is just barely fluid, no solid particles being present, but where any lowering of temperature would immediately cause some solid to form.

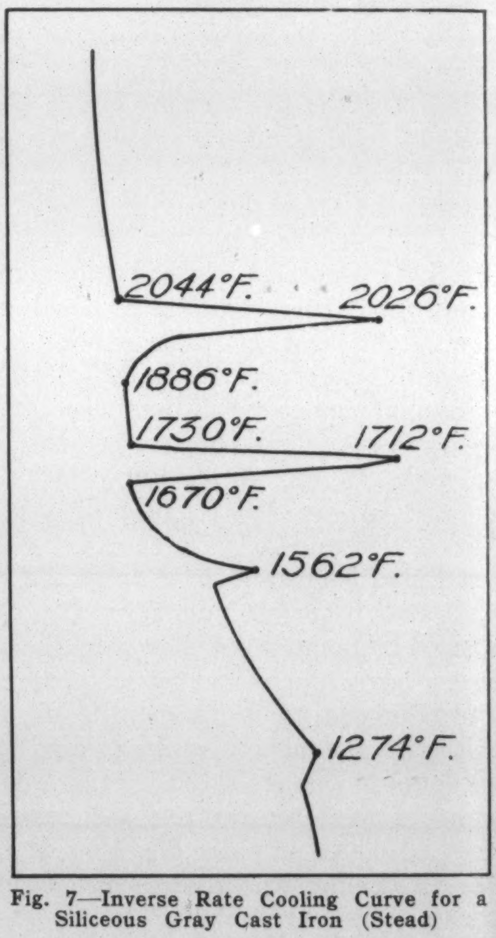

Fig. 7—Inverse Rate Cooling Curve for a Siliceous Gray Cast Iron (Stead)

Casting Temperatures.—There is a range of temperature within which the best results are obtained in casting each particular metal or alloy. The casting temperature is the temperature of the metal in the ladle, since it is impractical to measure the temperature of the iron in the mold, even though this latter may be the important temperature. It is evident that the iron is going to cool off during the pouring of the mold.

It is certain, then, that the metal must be superheated before pouring. Turner states that it is not possible to fix a definite amount of superheat. Metals with a high melting point lose heat more quickly during the pouring operation than those which have a lower melting point. Some of the many factors which enter into a determination of the proper casting temperature are:

The weight of the metal, i. e., whether handled in large or small amounts.
The specific heat.
The rate of pouring.
The size of the casting, i. e., ratio of surface to volume.

Turner proposes, as a very rough approximation, to take the degree of superheat as five percent above the temperature where the last solid melts. Thus an alloy melting at 600° C. might be poured at a temperature of 630° C. Copper with a melting point of 1083° C. might be poured at a temperature of about 1140° C. Sometimes, however, as much as twenty percent superheat may be needed, depending on the size and shape of the casting. According to the 5% superheat suggestion, the minimum pouring temperature for the alloy of Fig. 5 would be about 2300° F.

Once the metal is in the mold, solidification proceeds. If the feeding is not properly done, the first metal to reach points distant from the gate may be so cool that it solidifies against the cool walls of the mold, in such a way that it will not melt again, (or at any rate form a homogeneous mass), when more metal reaches the first "skin." An ideal condition for solidification is that all of the metal in the mold cavity shall cool at the same rate, but this is not possible if the sections of the casting differ in thickness unless chills are used, of course it may be desired to have "chilled" surfaces, for other reasons.

The actual solidification proceeds from the outer wall inward, and since the change of state involves a decrease in volume, more molten metal must be supplied to fill the space left. The shrinkage should be controlled by having the gates, risers and sprues of such section that all of the metal in the casting proper will be frozen before the fluid contact with the reservoirs of metal in the gates and risers ceases. It is the function of the gates and risers to serve as feeders of molten metal to the casting to compensate for the decrease in volume as the molten metal cools. After the metal is all solid, the contraction should proceed as expected in the solid material. Such contraction is provided for in manufacture of the pattern.

In gray cast iron the allowance for contraction is the net result of the allowance for three volume changes, viz., (1) change in volume due to change of state from liquid to solid. (2) Usual contraction of solid metal during cooling. (3) Expansions in the solid state due to liberation of graphite and the effect of certain of the metalloids present. The average net linear contraction of ordinary cast iron is said to be about one-eight inch per foot, but the actual contraction will vary with the composition and the casting temperature. The higher the casting temperature, the greater the contraction. The higher the combined carbon content, the greater will be the shrinkage.

The expansion and contraction phenomena are explained by W. H. Hatfield[2] as follows:

> "Immediately upon solidification the iron-carbon eutectic splits up into iron carbide and austenite, which action in itself most likely causes an expansion. In irons high in silicon, however, this carbide immediately dissociates, with the production of graphite, and hence a marked expansion takes place, presumably in proportion to the percentage of free carbon liberated. This is within 30–40° C. of the point of solidification. Further precipitation of carbon depends upon the size and composition of the mass." Contraction then occurs until the recalescence point is reached, about 700° C., where the solid solution changes to pearlite, and expansion again occurs.

Since casting temperature, size of casting, composition and rating of cooling, all affect the net contraction, it is not surprising to find contraction allowances varying, under different conditions, from one-tenth to three-eights of an inch per linear foot. Contraction, of course, is three dimensional, though specifications are usually given as linear values.

Aside from the provisions made in the dimensions of the pattern for contraction, care must also be taken in the dimensioning and manufacture of cores. It is often necessary to provide cores which will crush as the iron contracts.

Some authorities prefer to distinguish between "contraction" and "shrinkage" as follows: when the metal changes from liquid to solid it "shrinks," as the solid metal continues to cool, the decreasing volume is "contraction." In this way, when the gates or risers fail to supply the interior of the casting with sufficient metal as it solidifies, a "spongy" place results, or else the metal is pulled from some other part, leaving voids, and in any case a "shrinkage" defect occurs.

Conclusion

There are so many variables involved in the construction and pouring of a mold, that it is seldom of any use to attempt to apply any one chemical law or hypothesis in making explanations of either normal or erratic behavior. A knowledge of the gas laws may help to understand why certain defects occur, and in this way a remedy may be suggested. If a "blow" occurs in a casting it can be explained in terms of the combined laws of Charles and Boyle, that is, that the volume changes in the gases present were influenced by temperature in such a way that the pressure developed was more than the retaining wall could withstand. The control of gases in a mold is largely dependent on the choice of sand of proper permeability, proper placing of risers and correct venting.

A knowledge of the principles of flow of liquids may help toward a better understanding of problems in placing gates, sprues and risers.

The physical changes in a mold are mainly changes of state of the materials present. Changes of volume in either casting or mold may result, and these changes are largely dependent on the composition of the iron and the rate of cooling.

The chemical changes in a mold include the possible decomposition of facing materials, and the gasification of organic materials such as sea coal, if present. The presence of moisture may affect the permeability of the sand, and hence the rate of escape of gases.

Certain types of sand have low fusion points. They may fuse to a slag, and possibly even adhere to the iron. In a later article, the properties and testing of molding sand will be considered.

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[2] W. H. Hatfield, "Cast Iron in the Light of Recent Research, page 112, Charles Griffin & Co., Ltd., 2d ed., 1918.

Although competitive conditions in the motor industry have reduced the margin of profit for automobile manufacturers in 1929, the outlook for production of over 4,000,000 units in 1930 is counted upon to sustain the earnings of the principal accessory makers. Bohn Aluminum is one of the specialty companies which seems likely to do a large business in automotive parts, especially with the gain in proportion of eight-cylinder cars.

Company's earnings last year were better than $7 a share, mostly on its regular Bohnalite piston production, and the management plans to add two new products this year. A new Bohnalite connecting rod is understood to have been adopted by one of the leading eight-cylinder models, and the company is also working on a magnesium alloy for castings and forgings. It is predicted that a large field will be opened to this product as the weight of magnesium is about 62% of that of aluminum.

The American Manganese Producers Association, Washington, D. C. tells us that the new manganese ore concentrating plant of the Hy-Grade Manganese Production & Sales Corporation at Woodstock, Va., has been completed and thrown into production.

It is stated that the plant has a capacity of 30,000 tons of ferro-grade manganese ore per year, and that the ore will be shipped to ferromanganese manufacturers and steel mills in the East.

This is the third large domestic manganese plant to go into production in recent months. The other two are the plants of the Domestic Manganese & Development Co., Butte, Montana and the Georgia Manganese & Iron Co., White, Ga.

The potential capacity of these three plants combined exceeds 200,000 tons of ferro-grade manganese ore per year.

Type Metals in the Newspaper Industry

By John Helfrich*

> *It is indeed peculiar that alloys so largely used as the various type metals have had so little scientific study. In this article, Mr. Helfrich only scratches the surface. Yet the lack of definite data and the need for more scientific work are clearly brought out. It is of interest to compare the type metal situation with the cable-sheath situation, discussed in other articles in this issue. Both are lead alloys of industrial importance. Without minimizing the value of the work of laboratories like that of Mr. Helfrich, and of the Government Printing Office, one will not be unjust in saying that on the whole, the type metal industry uses rule-of-thumb metallurgy, while the cable industry is making use of scientific metallurgy.*

Type metals that find an application in the printing of newspapers are classified according to their use and are identified with the name of the machine from which they are cast.

Linotype metal is used in the casting of "slugs" or a line of type matter in the Merganthaler or the Intertype composing machine. The slug is placed in its proper position in the column contained in the chase or form. An impression of the chase is made on a matrix. It is only in the printing of newspapers with small circulation where a flat bed press is used, that the linotype slug finds an application for direct printing.

Monotype metal is used in casting a number of letters of a given size. These letters are used in setting news head lines or captions.

Stereotype metal is cast into plates from which the newspapers are printed. The paper board matrix after being impressed into the chase is dried and then "scorched" to remove the contained moisture. After being backed with special paper board to prevent sinking, the matrix is placed in the slot of the autoplate or stereotype plate casting machine. Casts of the stereotype metal are made at the rate of 2–3 per minute.

Some of the large metropolitan newspapers print certain of the Sunday Editions from electrotype plates. This is particularly true in printing magazine sections and comic supplements. The electrotype shells are first made by depositing copper or nickel on a wax mold. Then in order to make the electrotype shells of the required thickness, type metal is poured on the back of the shells.

Newspaper Type Metals

Type metals are composed of lead, tin and antimony in varying proportions depending on the particular use of the metal. The amount of the various metals in the alloy for a particular use will vary in accordance with the judgment of the man in charge of the operation.

Type metals should possess the following properties:

1st—They should cast readily.
2nd—They should fill the molds.
3rd—They should be as hard as possible.
4th—They should be as free as possible of impurities like arsenic, zinc and copper.

There are no set rules governing the composition of a particular type metal. As we stated previously, each foreman in charge of an operation has his idea of the proportions of tin and antimony the metal should contain.

Tin is added to type metal to give fluidity to the type metal when it is in a molten state and to give a clear definition of the cast after the metal has been cooled.

Antimony is added to give the requisite hardness to the metal.

Attempts are made to keep the type metal in good condition and the tin and the antimony in their proper proportions. For the sake of information the following table is recorded showing the composition of type metals used by newspapers and the range of the various metals.

	Linotype and Monotype Metals				Stereotype Metal		Electrotype Metal	
Tin	3.25%	3.50%	3.75%	4.00%	4%	5%	3%	4%
Antimony	10.75%	11.00%	11.25%	11.50%	13%	14%	2%	3%
Lead	86.00%	85.50%	85.00%	84.50%	83%	81%	95%	93%

The tentative formulas of type metals as contained in these tables are sound and are based on the actual working formulas of large metropolitan newspapers.

It is strange that apparently intensive investigation, from a scientific standpoint, has not been made of the type metals, at least the result of such investigation has not been published. Some newspapers send out samples of their metal to industrial laboratories to ascertain the percentages of tin and antimony contained in the type metal, calculating the percentage of lead by difference. This is all right as far as it goes but unless a representative sample is taken, the chemist's results are not a true indication of the real composition of the metal. The correctness of the sampling is wholly dependent on where the sample sawings were obtained. Metal that is poured in bars or "pigs" contains relatively more tin and antimony at the top of the bar, or at the lugs, than it does in the center of the bar. Experience has taught that the best way to sample a bar is to obtain sawings from two cuts across the width of the bar and the sawings from one cut the total length of the bar.

The constant reheating of type metal causes the formation of oxides of tin, lead and antimony. These with other impurities form a crust or slag on top of the molten metal.

At frequent intervals linotype slugs are remelted and cast into pigs or bars of the size required by the composing machines. This also applies to the materials meant for the monotype machines. In gathering the material for the melting pots, an accumulation of materials such as column rules and other "trash" enters the pots. In order to cleanse the metal, the process of "drossing" is resorted to. This consists of adding certain ingredients to the molten metal to reduce the oxide of the metals and to remove impurities such as arsenic and copper as well as what zinc may be contained. What to use in fluxing is considered by many as a "secret." Any or all of the following materials may be contained in a flux mixture: charcoal, rosin, sulphur, starch, tallow, borax, sal ammoniac.

The presence of oxides in linotype metal will cause imperfect "slugs" to be cast by a linotype machine. These imperfections in "slugs" are hollow spaces in the metal which cause the type metal to break down when submitted to the pressure of the matrix rolling machine.

What applies to the cleansing of linotype metal also applies to the cleansing of stereotype metal in a general way, with this exception. The "flux" is placed in the molten stereotype metal while in the pot.

In both instances, the dross is removed from the top of the molten metal and placed in special dross containers.

An analysis of the dross will show whether the dross losses of tin and antimony are high or not. In replacing the dross taken from the pots, the practice is to add the same amount of replacement metal, pound for pound. The replacement metal should contain the same proportions of tin and antimony as are contained in the dross in order to maintain the type metal in the proper proportions. If the dross contains 7% tin and 15% antimony, then the replacement metal should contain the same amounts.

Metals when alloyed in certain proportions have the property of forming what is known as eutectic mixtures. The word eutectic is defined as "Melting at a low temperature." The melting point of tin is 449° F.; the melting point of lead is 621° F. Yet these two metals form an eutectic mixture containing 63% tin and 37% lead with a melting point of 361° F. The melting point of the eutectic mixture is below the melting point of either of the two metals.

The melting point of antimony is 1166° F. yet lead and antimony form a eutectic mixture containing approximately 79% lead, 31% antimony with an eutectic melting point of 442° F. Antimony and tin form four series of solid solutions containing from 7.5–50% of antimony.

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* Director, Chemical Research, Hearst Newspapers.

A combination of lead, tin and antimony does not form a ternary eutectic mixture. What we really have in a type metal is two binary eutectic mixtures; tin and lead, antimony and lead and lead.

It has been found that the proper temperatures for casting stereotype metal range from 625–675° F.

It appears that the metal must have a temperature of at least the melting point of the uncombined lead (621° F.) before it will pour properly. The pouring temperature being high enough so that the lead has a small vapor pressure, there is a certain amount of metal loss in the form of condensed vapor or dust which is carried out the stack.

Analysis and Physical Examination

A chemical analysis can determine with a degree of accuracy the percentages of the various metals contained in an alloy or type metal and also the impurities such as copper, zinc, iron or arsenic. But a chemical analysis cannot tell the condition of a type metal or a toning metal. We can tell the amount of tin and antimony but we cannot tell by chemical analysis if a toning metal is made of virgin metal or if it is made of 50% virgin metal and 50% of recovered metal. At the present time we have to rely on the honesty of the company that supplies the toning metal. Recovered metal does not seem to have the same properties as virgin metal. It appears as if during the process of former use and recovery it suffers.

The best practice is not to attempt to recover dross but to sell it and insist on virgin metal for replacement.

Sometime ago the question arose as to whether or not stereotype metal is affected by the ink that adheres to a plate. Several tests were made and the results of these tests can be summarized as follows:

Three test bars were cast:

Size—1″ × 1″ × 16″
Bar No. 1—Stereotype metal
Bar No. 2—Stereotype metal with the addition of tabloid ink
Bar No. 3—Stereotype metal with the addition of blue ink

The three bars were sent to a metallurgical laboratory for physical tests.

Sample	Transverse stress	Deflection	Brinell hardness
Bar No. 1 (Stereotype metal)..........	800 lbs.	0.36″	14.8
Bar No. 2 (Metal plus news ink).......	780 lbs.	0.34″	13.3
Bar No. 3 (Metal plus blue mag. ink)...	820 lbs.	0.36″	14.3

The interpretation of the results are as follows:

Sample No. 1 (Stereotype metal)—Has a better shearing stress than Sample No. 2 and is harder than Samples No. 2 or No. 3.
Sample No. 2 (Metal plus tabloid ink)—Weaker in transverse stress and hardness than either of the other 2 samples.
Sample No. 3 (Metal plus blue mag. ink)—Higher in transverse stress than either of the other two samples and softer than Sample No. 1.

Conclusions:

1st—The ingredients in the tabloid ink lower the transverse stress of the stereotype metal and the relative hardness of the metal.
2nd—The iron cyanide contained in the blue magazine ink increases the transverse stress but lowers the relative hardness of the metal.

Inasmuch as these tests were conducted with inks not in general use by Metropolitan Newspapers, the value of these tests can only be of service to the laboratory. They prove that the mineral matter contained in some of the pigments used in making inks have a certain effect on the stereotype metal.

The physical examination of type metals is of equal importance to that of the chemical analysis. It is an established fact that the various types of metal alloys form definite crystalline structures, each differing from the other, depending on the proportions of tin-antimony-lead.

We believe that metallographic research and making physical tests such as transverse stress, will enable the detection of the presence of recovered metal in combination with virgin metal.

It is evident, in view of the increasing cost of tin and the decrease in the amount of tin available, that it behooves the newspaper publishers to collaborate with the type metal founders in the production of suitable type metal.

It is only recently that the more successful dealers in "junk" metals have been designated secondary metal men. The change in title is one indication of our growing appreciation of the importance of recovering and preparing for re-use many of the metals which are becoming scarce and some of which would be in the famine stage but for such reworking.

The growth of the secondary metal business is one indication of conservation, though increases in the turnover of metals would naturally follow the phenomenal industrial growth of the last few years. *Even the ability to rework many of the metals and their alloys does not excuse us from choosing the metals best suited for a particular purpose nor does it justify the continued though occasional use of some important metals in a form which makes the recovery impossible.*

In many instances the process of refining type metal dross is not based on a firm scientific foundation. Very few refiners conduct research in the effort to make a better product. The manufacturing basis is production and not quality.

We have studied with considerable interest, the reports on type metals by the Chief of Tests, U. S. Government Printing Office[1]. While the conditions at that plant are somewhat different than exist at newspaper plants, yet the problems relating to type metals are identical. We have profitted by their observations and recommendations.

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[1] Annual Report of the *Public Printer*, **1925**, page 129; **1926**, page 58; **1927**, page 69; **1928**, page 110.

A New Alloy Steel Company

The formation of a new steel company, Associated Alloy Steel Co., Inc., was recently announced by M. T. Lothrop, president The Timken Roller Bearing Company, Severn P. Ker, president The Sharon Steel Hoop Company and H. G. Batcheller, vice-president Ludlum Steel Company.

The company has been incorporated to sell exclusively corrosion-, heat- and wear-resisting alloy steels produced by the Timken, Sharon and Ludlum companies. These products include Nirosta, Nitralloy and Stainless steels. Nirosta is a high-chrome, high-nickel alloy resistant to the corrosive action of air, salt water and acids at high temperatures and high pressures, which may be welded, drawn, spun and highly polished. Nitralloy is a special alloy steel which obtains the hardest known wearing surface when treated by an ammonia process. Both of these alloys were developed by Fried. Krupp A.-G., Essen, Germany.

The board of directors includes: H. G. Batcheller, vice-president Ludlum Steel Company; J. Reid Evans, secretary and treasurer The Sharon Steel Hoop Company; Severn P. Ker, president The Sharon Steel Hoop Company; M. T. Lothrop, president The Timken Roller Bearing Company; J. F. Sprough, secretary and treasurer The Timken Roller Bearing Company; Neil F. Towner, attorney, Albany, New York.

The active management will be under the direction of David B. Carson, vice-president and treasurer, formerly sales manager, Development Division, Central Alloy Steel Corporation. Headquarters of the company will be located at Cleveland, Ohio, and branch offices and warehouses established in strategic centers throughout the country. Mill facilities are being expanded and additional equipment for the most recent production practices is already installed.

Mr. Batcheller, president of the new company, made the following statement to the press:

"We feel that Associated Alloy Steel Co. meets a very definite need in the alloy steel situation, providing at once the coordinated production of these materials in all forms under the finest supervision and metallurgical research and a centralized source of supply from which customers may obtain the varied forms necessary to meet their requirements.

"It provides greater efficiency in engineering and servicing and the economy in marketing necessary to supply materials at the lowest possible price."

Correlated Abstract

Dr. Gillett, the editorial staff and specially selected contributors will prepare abstracts reviewing the work recently reported pertaining to certain subjects. These reviews will take into consideration the work of a number of workers. The current literature will be covered in the Abstracts of Current Metallurgical Literature.

Some Observations on the System Iron-Nitrogen

By Robert F. Mehl[1] and Charles S. Barrett[2]

> *The extremely hard surfaces obtainable by nitriding suitable steels are of interest to everyone who meets the problem of reducing the wear of steel parts.*
>
> *Nitrided steel is becoming an important competitor of carburized steel.*
>
> *The whole problem of nitriding is new, and much of the effort put upon it has to be by cut and try methods for lack of sufficient knowledge of the fundamentals. To say nothing of the lack of exact knowledge of the nitride coatings obtained on the special chromium-aluminum-molybdenum nitriding steels, the compounds formed between nitrogen and iron itself still resist a complete understanding.*
>
> *In this article the authors present evidence to indicate that the iron-nitrogen compound richest in iron may have only $^1/_2$ or $^1/_3$ the number of iron atoms other investigators believe to be present. He uses the microscope, the X-ray spectrograph, argon gas and a razor blade in his research. The modern metallurgist is applying all the tools at his command to the solution of fundamental problems.*

The Division of Physical Metallurgy at the Naval Research Laboratory has been engaged during the past year in a comprehensive study of Widmanstätten figures in ferrous and non-ferrous alloys. An inspection of published photomicrographs of the "nitride needles" in Fe-N alloys led to the idea that the "nitride needles" are indeed not needles but plates,[3] and that, forming by precipitation from a solid solution (*N* in α-Fe), they are in fact a Widmanstätten figure.

Ample proof has been obtained of the plate-like nature of the so-called needles. The immediate object of our work was to determine the lattice plane in α-Fe upon which the nitride plates form. An inspection of a large crystal of nitrided iron[4] (decarburized mild steel) plainly showed several families of parallel needles (Fig. 1). Accurate measurement, upon several pieces, of the angles the needles form with some reference line (the edge of the piece) disclosed the fact that there is a maximum of twelve directions, corresponding to a family of twelve planes. A determination of the orientation of the α-Fe crystal with respect to the plane of polish and the edge, and a matching of the directions of the nitride plates on the polished surface with the lattice planes, disclosed the fact that the nitride plates form on the (210) plane in the α-Fe. A full account of this work, and of other work of a similar type on Widmanstätten figures, will be published later.

During this investigation several unusual phenomena were noted and have led to the publication of this note. Because of the great interest in the Fe–N system it is thought wise not to delay the publication of our findings.

1. That the solid solubility of N in α-Fe increases with increasing temperature there can hardly be any doubt. In support of this we have the fact that the "needle" appears only in slowly cooled or "artificially aged" samples, that the system shows age hardening in the composition range 0–0.5% N[5], and now the fact that the "needle" structure is in fact a Widmanstätten figure, for which the necessary condition is a change in solubility with temperature. To adduce additional evidence in support of this increasing solubility with increasing temperature attempts were made to dissolve the nitride plate by annealing just below the eutectoid temperature (600° C.). The nitrided piece shown in Fig. 1 was heated at 540° C. in argon for 20 hrs. and quenched in water. The appearance of the polished specimen was indistinguishable from Fig. 1. A 90-hr. anneal at 540° C. and in argon was likewise unsuccessful in dissolving the nitride plates. This is a very unusual result, for such precipitates ordinarily dissolve within very short time.

A second piece nitrided 90 hrs. at 540° C. and cooled in the furnace was reheated to 540° C. in a slow stream of ammonia gas, held 70 hrs., and quenched in water. This piece showed on microscopic inspection the original nitride needles only, apparently entirely unchanged. Inspection of a similar specimen, but cooled in the furnace instead of quenched, showed that there had been a second precipitation of nitride. This is illustrated in Fig. 2, in which the large needles are from the first precipitation and the small from the second. Fig. 2 also shows the formation of nitride at a grain boundary.

It would appear, therefore, that the rate of solution of the nitride plates is extremely low. It would seem possible to increase the amount of nitride indefinitely by repeated treatments of the type indicated above. The suggestion is obvious that a reheated specimen quenched from the eutectoid temperature should show little or no aging effects (at least due to N), but this experiment has not been performed.

2. In looking for an explanation of the (210) plane of precipitation the crystal structure of the iron nitrides was considered in connection with the geometry of the (210) plane. The precipitated nitride plate should have the composition of the stable compound richest in Fe. A chemical analysis of these plates is, of course, out of the question, but it was thought possible to identify them by means of their crystal structure. Hägg[6] designates the nitride richest in iron as Fe_4N with a face-centered cubic structure. The next phase Hägg identifies as Fe_3N with an hexagonal structure. Fe_2N has a structure nearly identical with that of Fe_3N but orthorhombic. Osawa and Iwaizumi[7] found Fe_4N with a cubic symmetry, and also a hexagonal structure indistinguishable in symmetry and dimension from Hägg's Fe_3N, but concluded that the compound was Fe_2N. Epstein, Cross, Groesbeck and Wymore[8] are in disagreement with these results and consider the compound Fe_6N to intervene between Fe and Fe_4N. These authors justly point out the great difficulties in the interpretation of the data available, since it is not possible to separate the layers identifiable under the microscope and to subject each to analysis. This separation can, however, be made for one compound, namely, that forming the plates.

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[3] A. Fry suggested this in his first paper, *Kruppsche Monatshefte*, **4**, 138 (1923).

[4] The analysis of this iron was as follows: C = 0.051%, P = 0.054%, S = trace, Si = 0.094%, Mn = 0.369%.

[5] R. S. Dean, R. O. Day and J. L. Gregg, *Technical Publication* No. 193, *American Institute of Mining & Metallurgical Engineers*, **1929**.

[6] Gunnar Hägg, *Nova Acta Regiae, Society Scientific Upsaliensis (IV)*, **1**, 95 (1929).

[7] G. Osawa and S. Iwaizumi, *Science Reports Tohoku Imperial University* (Sendai), **18**, 79 (1929).

[8] S. Epstein, H. C. Cross, E. C. Groesbeck and I. J. Wymore, *Bureau of Standards, Journal of Research*, **3**, 1005 (1929).

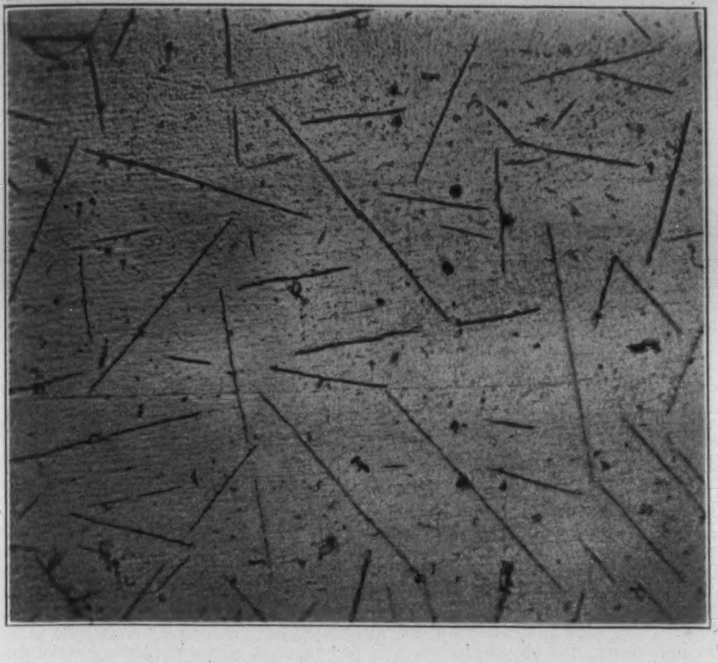

Fig. 1—Iron (Decarburized Mild Steel) Single Crystal, Nitrided for 90 Hrs. at 540° C. Cooled in Furnace. Etched with Picric Acid in Alcohol. 250 Diameters. (Reduced $^2/_5$.)

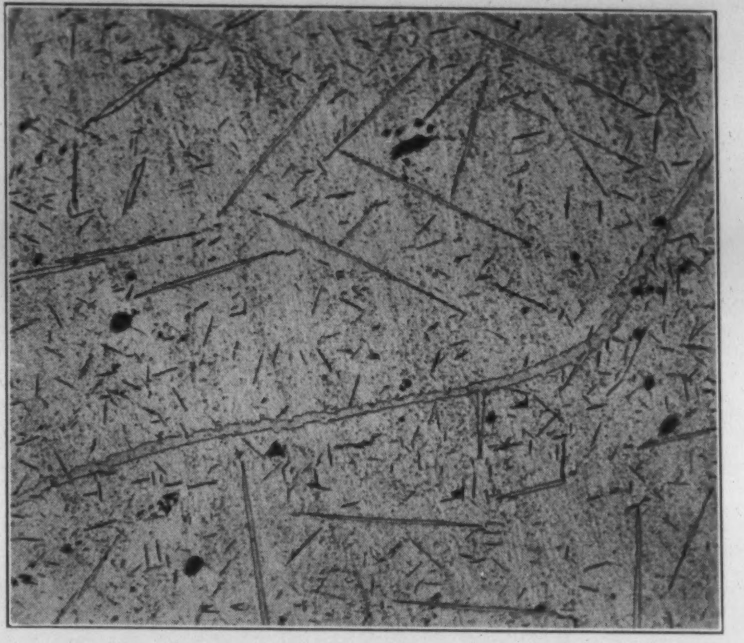

Fig. 2—Iron (Decarburized Mild Steel), Nitrided 90 Hrs. at 540° C., Cooled in Furnace, Renitrided 70 Hrs., Cooled in Furnace. Etched with Picric Acid in Alcohol. Shows Double Precipitation. 250 Diameters. (Reduced $^2/_5$.)

A specimen similar to that shown in Fig. 1[9] was etched deeply with a concentrated solution of picric acid to which a small amount of nitric acid had been added. After a time the surface was scraped with a razor blade to break off the nitride plates which the etching had thrown into relief. This treatment was repeated several times until enough scraped powder had been obtained to use in taking a powder diffraction photogram. In effect this treatment was a concentration of the nitride plate to a degree where its characteristic X-ray diffraction lines could be found.

The photograms were taken with Molybdenum K_α radiation. Fe was used to calibrate the film. The positions of the diffraction lines obtained agree satisfactorily for those Hägg found, not for Fe_4N but for Fe_3N. The calculated interplanar distances are given in the following table. No data is given for Fe_4N since an inspection of Hägg's data (expressed not as d_{hke} but as $\sin^2 \theta/2$) show that there is no possible coincidence. Hägg finds the dimensions of the unit cell of Fe_3N to vary slightly with N content. The values of d_{hke} for this phase poorest in N are designated "lower limit," and those for this phase richest in N "upper limit."

Table of Diffraction Line

(Converted into the appropriate interplanar distances d_{hke})

Indices *hke*	d_{hke} Mehl and Barrett	d_{hke} Hägg, "Fe_3N," lower limit	d_{hke} Hägg, "Fe_3N," upper limit	d_{hke} Hägg, "Fe_2N," with indices
10.0	2.370	2.331	2.399	2.400 (020) (110)
00.2	2.189	2.178	2.210	2.205 (002)
10.1	2.081	2.076	2.107	2.110 (111) (021)
10.2	1.609	1.607	1.624	1.623 (112) (022)
11.0	1.366	1.359	1.403	1.386 (130)
				1.379 (200)
10.3	1.240	1.245	1.256	1.255 (113) (023)
				1.206 (040)
20.0	...	...	1.199	1.198 (220)
				1.188 (132)
11.2	...	...	1.173	1.170 (202)
				1.161 (041)
20.1	1.136	1.137	1.157	1.155 (221)
00.4	1.094	1.099	1.104	1.106 (004)
20.2	1.040	1.038	1.054	1.058 (042)
				1.053 (222)
10.4	...	...	1.003	
20.3	0.922	0.919	0.929	
12.1	0.876	0.874	0.888	
11.4	0.855	0.856	0.863	

Lines obtained on the film but originating in the admixed Fe have not been included in the table.

The values of Hägg have alone been used for comparison, not because of any distrust of those of Osawa and Iwaizumi but because Hägg's values were first available to us. Osawa and Iwaizumi do not give Fe_3N but account for all of their lines on the basis of two compounds, Fe_4N and Fe_2N. The three columns of d_{hke} (from Hägg) given in the table are nearly identical, and agree very closely to the lines Osawa and Iwaizumi ascribe to Fe_2N.

It may be seen from the table that the values we have obtained agree very closely with Hägg's values for Fe_3N at the lower homogeneity limit, but do not depart greatly from those given for Fe_3N at the higher homogeneity limit or from those for Fe_2N. They agree, therefore, closely with those obtained by Osawa and Iwaizumi for Fe_2N.

It is realized that these results cannot be reconciled with existing opinion upon Fe-N equilibria. The nitride plate precipitate should have the composition of the stable compound richest in iron, Fe_4N according to Hägg, and Osawa and Iwaizumi (Epstein, et al, suggest a compound Fe_6N), yet our results on the crystal structure of the nitride plate indicate it to be the same as Hägg's Fe_3N or Osawa and Iwaizumi's Fe_2N.

It is difficult to know how to attempt a reconciliation, and indeed such an attempt would certainly be premature. The trouble probably lies in the stability of the nitrides, for any constitutional diagram of a system composed of phases with high decomposition pressures[10] and yet which disregards the pressure variable can only be highly tentative. In other words, no satisfactory account of Fe-N alloys can be written until a p-t-x diagram replaces the present t-x diagrams.

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[9] No constituent other than the nitride plate could be recognized in the specimen upon microscopical investigation.

[10] An account of the decomposition pressures of the iron nitrides, by P. H Emmet, F. Brunauer and S. B. Hendricks of the Fixed Nitrogen Research Laboratory, will shortly appear in the *Journal of the American Chemical Society*.

Sivyer and Nugent Foundries Combine: Form World's Largest

The Directors of the Sivyer Steel Casting Company, Milwaukee, and the Nugent Steel Castings Company, Chicago, have announced the consolidation of their companies. Both Sivyer and Nugent have come to be recognized as being among the most outstanding electric steel foundries in the United States. Both have been active in the research and pioneering of new alloy steel castings to meet special conditions.

By combining, the managements expect to provide greater and more flexible facilities for the handling of their large alloy tonnages.

The new company will be unique in its industry. The production capacity of 1400 tons per month, of small and variable section castings in high carbon and alloy steels, is the largest of its kind. The two-plant set-up provides exceptional flexibility. Castings can be segregated by type to provide more routine foundry practice. Production can be stabilized, and the alloy business of both foundries can be centralized in one foundry under exceptionally close control.

The combined organizations will function under the name of The Sivyer Steel Casting Company, with the home office located in Milwaukee.

Abstracts of Current Metallurgical Literature

In this section, abstracts of metallurgical articles in various publications will appear. These abstracts are not critical, but merely review developments as they are recorded. Every effort will be made to report on all articles as soon as possible.

GENERAL

How Metallurgy is Meeting Demands of Chemical Industries. B. D. Saklatwalla. *Iron Trade Review*, Aug. 29, 1929, pages 524–525, 561. See Metals & Alloys, July 1929, pages 8–13.

Progress in Non-Ferrous Metallurgy in 1929. *Mining and Metallurgy*, Jan. 1930, pages 4–12.

A survey by various authorities on the progress of non-ferrous metallurgy—new developments in processing, technology and application of non-ferrous metals. The topics and their authors are as follows: "Progress in Theoretical Metallurgy during 1929," by R. S. Dean; "Sand Cast Alloys of Copper," by J. W. Bolton; "Lead and Lead Alloys," by G. O. Hiers; "Review of the Zinc Industry for 1929," by F. W. Harris; "Aluminum and Aluminum Alloys," by Sam Tour; "Nickel in 1929," "Non-Ferrous Secondary Metals," by E. R. Darby; "Technology of the Precious Metals," by G. F. Kunz & E. M. Wise. VSP

Iron and Steel Metallurgy in 1929. G. B. Waterhouse. *Mining and Metallurgy*, Jan. 1930, pages 34–36.

The iron and steel industry was exceedingly busy and prosperous during 1929. Lake shipments of ore amounted to 65,000,000 tons; steel ingots produced were about 57,000,00 tons. Coke-oven developments were along the line of firing with other gases and setting free coke-oven gas. Another development in coke-oven practice was the increasing value of surplus coke-oven gas for city distribution. Blast furnace design continued toward the large hearth. There were a number of developments in steel making practice. Researches on alloy steels were quite active. In the tool steel field the development of Widia and Carboloy is of interest. In the field of metallography great work has been done on non-metallic inclusions, particularly in alloys and high-grade steels. The most striking of all developments is the interest in industrial and pure research, and recognition of its importance to the iron and steel industry. VSP

German vs. American Steel Practice. F. L. Estep. *Iron Age*, Nov. 28, 1929, pages 1441–1442.

Abstract of a paper presented before the Metropolitan section, A. S. M. E. Nov. 12 and sponsored by the Iron and Steel Division of the Society. Gives some of the outstanding points of blast furnaces, steel making, soaking pits, blooming and heavy finishing mills, tube mills and handling methods in both countries. Germany leads in combustion while America is ahead in mechanisms. VSP

Steel Castings Will Meet Demands. R. A. Bull. *Iron Age*, Jan. 2, 1930, pages 43–44.

Discusses the increased use of alloy steels, wider use of medium manganese steel and reclamation of steel foundry sand. Considers the importance of research in the steel casting industry. VSP

The Present Status of Cemented Tungsten Carbide Tools and Dies. Zay Jeffries. Metals & Alloys, Nov. 1929, Vol. 1, pages 222–225.

Slightly condensed from a paper read before the Machine Shop Practice Division of the A. S. M. E. at Cleveland, Oct. 1, 1929.

Strategic Raw Materials. Roger Taylor. Metals & Alloys, Vol. 1, July 1929, pages 5–7.

The author emphasizes the need for certain materials necessary in case of war, not only by the army and navy but also by industry. The metals considered are antimony, chromium, manganese, nickel, platinum and mercury. The 3 possible methods of meeting a shortage are stimulation of domestic production, maintenance of a war reserve stock and substitution.

Demands of Chemical Industry on Metallurgy. B. D. Saklatwalla. Metals & Alloys, July 1929, Vol. 1, pages 8–13.

Paper presented before the Delaware Section of the American Chemical Society, March 20, 1929. The properties of metals of greatest interest to the chemist are: resistance to erosion, corrosion and gas penetration. Further, heat conductivity, surface density, ability of brazing and welding should be considered.

Open-Hearth Developments in 1929. Sidney G. Koon. *Iron Age*, Jan. 2, 1930, pages 35–36.

Discusses the three outstanding developments during the part year. They are: (1) increasing use of control devices for fuel and air; (2) increasing interest in the use of mixed gases of controllable heating value; (3) continuation of the movement toward larger furnaces. VSP

Trend in Gray Iron for 1930. Richard Moldenke. *Iron Age*, Jan. 2, 1930, page 36.

Discusses the development of a "high-test" cast iron with a tensile strength of approximately 60,000 lb./in.^{2}. Some foundries pay special attention to gray iron castings suitable for acid and heat-resisting requirements. The coming year is certain of developments in the gray iron industry. Much investigation is being done on wear-resisting qualities of cast iron. VSP

Advances in Non-Ferrous Field. W. M. Corse. *Iron Age*, Jan. 2, 1930, pages 55–56.

Discusses the increased use of the more important non-ferrous metals and alloys during the past year and the outlook for the coming year. Considers also the hard facing metal "Hascrome," and the acid resisting alloys "Hastealloy" developed by the Haynes Stellite Co. VSP

Developments of the Blast Furnace. *Iron Age*, Jan. 2, 1930, pages 37–39.

Discusses development of larger furnaces, having daily capacities of 1000 tons or more. Use of blast furnace gas for underfiring coke ovens, for making open-hearth steel or for use in heating furnaces. These developments have involved changes in stacks, blowing equipment, gas cleaners, hot blast stoves and boilers. VSP

PROPERTIES OF METALS

Melting, Mechanical Working and Some Physical Properties of Rhodium. Wm. H. Swanger. Metals & Alloys, Dec. 1929, Vol. 1, pages 263–267.

Information is given on the melting and working of rhodium. The melting point is determined as 1984° C. Other properties are given in the article.

Beryllium. Menahem Merlub-Sobel. Metals & Alloys, Aug. 1929, Vol. 1, pages 69–70.

The methods of reduction from its ores as well as its properties are mentioned.

Regularities in the Arc Spectrum of Hafnium (Hf_1). William F. Meggers & Bourdon F. Scribner. *Bureau of Standards, Journal of Research*, Jan. 1930, Vol. 4, pages 169–175.

The first regularities among lines characterizing the first spectrum of hafnium (Hf_1) have been discovered. Combinations of seven low energy levels with higher excited states account for more than 200 lines. Inner quantum numbers have been assigned to the energy levels and a tentative identification of the seven low levels is suggested. XL

Ductile or Brittle. (**Zäh oder spröde.**) P. Ludwik. *Metallwirtschaft*, Sept. 6, 1929, pages 872–875.

Ductility and brittleness of metals is largely influenced by the relation of breaking strength and ductility, the kind of stress and fracture. High ductility is due to high tearing resistance. With increasing velocity of deformation, slip resistance increases more rapidly than resistance to fracture. Thus brittleness increases particularly if a considerable increase of the specific velocity takes place as a result of notching. In case of 3 axial tensile stresses, fracture occurs after less deformation and strain hardening the more the largest and smallest principal stresses approach one another, i. e., the greater the strain hardening is. Hence some materials may appear very brittle which exhibit great ductility if submitted to the customary tensile test. Equal conditions assumed, a material will have lower notch toughness the larger the slip resistance; the lower tear resistance, the heavier strain hardening is. Upon pressure stress, considerable secondary tensile stresses can show up, if crystals shift in relation to one another. By an additional, correspondingly large hydrostatic pressure these displacements are presented, thus forcing an inter-granular deformation. Fatigue fracture is independent of the ductility. A brittle fracture occurs probably due to repeated alternating stresses which result in breaking up space lattice. EF

The Magnetic Quadruple-Momentum of the Iron Atom. (**Ueber das magnetische Quadrupolmoment des Eisen Atoms.**) N. S. Auklov. *Zeitschrift für Physik*, 1929, Vol. 57, No. 3–4, pages 249–256.

The quadruple-momentum of the iron atom is determined by two independent methods of observation: first, by the area between the curves referring to different directions of the field for the magnetization component parallel to the field, and second, by the course of the magnetization curves for the component vertical to the field. The density of the bi-polar energy of the body-centered lattice is evaluated exactly and the density of the quadrupolar energy with an accuracy of one promille. Ha

Properties of Nickel in Caustic Evaporation. Robert J. McKay. *Industrial & Engineering Chemistry*, Dec. 1929, pages 1283–1288.

In caustic evaporation the corrosion rate of nickel in caustic solution is negligible. In steam, corrosion may occur with high CO_2 content, but when this is kept low, corrosion is minute. Potentials as high as 0.5 volt are obtained by contact between nickel and cast iron or steel, and rapid corrosion results in strong hot solutions. Hard-drawn nickel tubing has good strength and hardness characteristics for evaporator tubing. Hot-rolled plate should be used for tube sheet. Methods of forming and welding nickel linings are described. MEH

Metals of the Tungsten and Tantalum Groups. Clarence W. Balke. *Industrial & Engineering Chemistry*, Nov. 1929, pages 1002–1007.

Columbium and tantalum, molybdenum and tungsten are discussed in relation to their properties and their ores. All four metals are very resistive to chemical corrosion, tantalum is most resistive. Tungsten has the highest melting point of all substances except carbon. Tantalum and columbium are able to absorb very large quantities of gas, particularly hydrogen, and it becomes necessary to use high-vacuum furnaces for their production in bar form. The metallurgy of tungsten is given in detail. It has been found that in the case of this metal, the presence of gold causes the bars to swell and crack during the sintering operation. Ingots containing platinum even in small quantities break up during the first or second pass through the swaging dies. Iron, cobalt and nickel produce an exaggerated grain growth in the bars during sintering and when heated to the usual temperature they expand, crack and become full of voids. Other objectionable impurities are sodium in a few hundredths of 1%, and calcium in appreciable quantities. MEH

Metallography of Commercial Thorium. E. S. Davenport. *Technical Publication* No. 226, *American Institute of Mining & Metallurgical Engineers*, 14 pages.

The author considers the following questions: properties of Th produced by the Ca-$CaCl_2$ process, analysis of typical samples, effect of cold working upon specific gravity, Rockwell B-scale hardness, tensile properties, annealing temperature range and microstructure, etched and unetched and a new etching method.

PROPERTIES OF NON-FERROUS ALLOYS

Characteristics of Hy-ten-sl Bronze. *American Machinist*, Sept. 26, 1929, page 561.

Hy-ten-sl bronze has great strength, toughness, hardness and resistance to corrosion, combined with good machining properties. Useful for gears and bearings. Gives table of physical characteristics. RHP

Aluminum Alloys for Pressure Die Castings. H. W. Gillett. Metals & Alloys, Oct. 1929, Vol. 1, page 176.

Critical abstract giving a résumé of Sam Tour's A. S. T. M. paper having the above title. Comment Dec. 1929, page 261.

Two Decades of Precipitation Hardening Alloys. Zay Jeffries. Metals & Alloys, July 1929, Vol. 1, pages 3–4.

Beginning with discovery of duralumin by Dr. Alfred Wilm, the history of precipitation hardening alloys is briefly covered.

White Metals, Brasses and Bronzes. Part 2. E. Perry. *Metal Industry*, New York, Nov. 1929, pages 509–510.

Describes the properties and making of various bearing metals. Gives a list of the bearing metals and their chemical composition. VSP

Electric Conductivity, Corrosion and Possibilities of Heat Treatment of Cadmium Zinc Alloys. G. Grube & A. Burkhard. Metals & Alloys, Dec. 1929, Vol. 1, pages 294–296, 300.

Translation of an article from *Zeitschrift für Metallkunde*, July 1929, pages 231–234. See Metals & Alloys, Oct. 1929, page 177.

The Solubility of Copper in Silver. M. Hansen. Metals & Alloys, Nov. 1929, Vol. 1, pages 248–250.

Translation from *Zeitschrift für Metallkunde*, June 1929, pages 181–184. See Metals & Alloys, Sept. 1929, page 118.

Light Alloys. Zay Jeffries. Metals & Alloys, Dec. 1929, Vol. 1, pages 267–271.

Paper delivered at the World Engineering Congress, Tokio, Japan, Oct. 29 to Nov. 7, 1929. Considerable data on aluminum alloys and magnesium alloys is given.

Work on Beryllium and Its Alloys. H. W. Gillett. Metals & Alloys, Aug. 1929, Vol. 1, pages 71–72.

A correlated abstract covering the work carried out by Siemens & Halske on this metal. The original articles appeared in the *Wissenschaftlichen Veröffentlichungen aus dem Siemens-Konzerns*, Vol. 8, No. 1, 1928.

Have Heat-Treated Aluminum Alloys a True Endurance Limit? H. W. Gillett. Metals & Alloys, July 1929, Vol. 1, pages 21–22, 37.

A correlated abstract of a recent Russian investigation and one made at Wright Field.

P M G—A New High Copper Alloy. *American Metal Market*, No. 233, Dec. 3, 1929, page 2.

A formidable competitor to gun-metal and other brasses and bronzes has been developed at the Naval Construction Works, Barrow-in-Furness of Vickers-Armstrong, Ltd. The short freezing range of the alloy (900–950° C.) is probably responsible for the excellent casting qualities and minimum of foundry wasters. Cast P M G metal has an average yield point of 12 tons/in.^{2} and a tensile strength of 22 tons/in.^{2}. Forged P M G metal has greater strength and hardness compared to a 70% Cu 30% Zn brass, or a 9% Al-bronze. Extrusion, anti-friction, cold bend and high temperature service tests indicate its superiority. WHB

Non-Ferrous Metals and Alloys. I. George M. Enos. *Modern Machine Shop*, Jan. 1930, pages 22–32.

This is the first of a series of articles dealing with the nature and properties of the common non-ferrous metals and their alloys. The occurrence and recovery of Cu, Al, Pb, Zn, Ni, Cr and Sn are given with a table showing some of their properties. MLM

Useful Cast Aluminum Alloys. (Brauchbare Aluminiumguss-Legierungen.) H. Reininger. *Metallbörse*, June 1, 1929, pages 1209–1211; June 8, 1929, pages 1266–1267.

The author points out the difficulties involved in piston material in regard to strength at elevated temperatures, expansion, heat absorption and transmission, specific gravity, corrosion resistance to fuel and combustion gases. The properties of cast iron are compared with a piston of light metals of Al-Cu base and a number of other piston alloys, whose composition are given. The influence of Fe, Ni, Mn, Sn, Pb, Si, Zn, Sb, Mg in Al-piston alloys upon the Al matrix is given as well as the thermal treatment. Hardness of sand cast cylinder blocks is not increased by annealing and quenching. With permanent molds a hard and fine grain is obtained, so that no further treatment is required. EF

Correlation of the Ultimate Structure of Hard-Drawn Copper Wire with Electrical Conductivity. R. W. Drier & C. T. Eddy. *Technical Publication* No. 259, *American Institute Mining & Metallurgical Engineers*, 12 pages.

The average specific resistivities from the skin to the core in annealed copper wires did not vary since crystal orientation is not preferred in contrast with hard drawn wires exhibiting an orientation in which the cube edge is parallel to the fiber axis, i. e. the direction of drawing. Similar behavior in preferentially orientated wires was found to exist in tensile measurements. The nature of the core approaches that of a single crystal and evidence seems to refute the theory of higher conductivity in single crystals. EF

The **Cast Tin-Copper Alloys. (Zur Kenntnis der gegossenen Zinn-Kupfer Legierungen.)** Dr. W. Claus & H. Goeke. *Zeitschrift Vereins Deutscher Ingenieure*, Aug. 3, 1929, pages 1094–1096.

The following standard alloys have been investigated with regard to uniformity of structure, precipitation in different parts of section and length of cast ingot, hardness and other mechanical properties:

Rolled bronze 6 = WB$_z$6 with 94% Cu and 6% Sn
Cast bronze 10 = GB$_z$10 with 90% Cu and 10% Sn
Cast bronze 14 = GB$_z$14 with 86% Cu and 14% Sn
Cast bronze 20 = GB$_z$20 with 80% Cu and 20% Sn (Bell bronze)

It was shown that a difference existed in contents of tin of from 0.4 – 2.0% between core and outer parts; this depended partly on the material which was used for molding, further it was different in different parts of the ingot, and also on how the ingot was cast, upright or horizontal. The tests and results are illustrated by a large number of diagrams and tables. Ha

Directions for the Construction of Silumin Castings. (Richtlinien für die Konstruktion von Silumingusstücken.) W. Hart. *Metallwirtschaft*, Oct. 4, 1929, pages 966–967.

The properties of the light metal silumin which have to be taken into consideration in the manufacture of castings are discussed from a foundryman's viewpoint. EF

Investigations of the German Aeronautical Testing Institute 1928–1929. (Arbeiten der Deutschen Versuchsanstalt für Luftfahrt 1928–1929.) *Deutsche Motor Zeitschrift*, Oct. 1929, pages 522–526.

The results of the following investigations are briefly presented: Kf 6/3 Quenching tests with duraluminum 681 B in boiling water by K. L. Meissner; Kf 25/10 Annealing investigations with Al-coated Lautal (Allautal) by K. L. Meissner; Kf 196/1 Testing of duraluminum 681 ZB by K. Matthaes; Tensile properties of Alclad 17–ST-sheets by K. Matthaes; Kf 13/26 Elasticity tests on magnesium alloy by K. Matthaes; Kf 13/14 Investigations on light metal sheets out of a group of five alloys by K. Schraivogel; Kf 6/2 Influence of artificial aging on the physical properties of Duraluminum B 1/3 by K. L. Meissner; Vf 18/4 Tensile testing of a light metal fuel tank by K. Schraivogel; K 28/9 Testing of two end ribs of elektron AZM by K. Schraivogel; Kf 7/18 Corrosion resistance of various unprotected light metals by E. Rackwitz & E. Schmidt. All investigations are subdivided in the following manner: (a) Reason for investigation(b), Performance of the investigation (c), Results. EF

On Bearing Metals on Lead, Antimony and Tin Base. (Ueber Lager metalle auf Blei-, Antimon- und Zinn-Basis.) H. Müller. *Zeitschrift für Metallkunde*, Sept. 1929, pages 305–310.

After the general introduction which mentions the tendencies in the development of bearing metals, the author fully discusses all requirements which have to be met with in the manufacture of high quality bearing metals in regard to casting and physical properties as Brinell hardness, tensile strength, elongation and wear resistance. The scientific side of the problem is discussed in detail, the significance of the explained ternary and quaternary diagrams is outlined and the constituents are explained in the numerous microphotographs with the object of paving the way for further investigations with other hardening additions several of which are considered. The paper which was presented at the special meeting "Schmelzen und Giessen" before the "*Deutsche Gesellschaft für Metallkunde*," May 27, 1929, includes discussion. EF

Wear and Mechanical Properties of Railroad Bearing Bronzes at Different Temperatures. (Proprietes mechaniques et resistance a l'usure a differentes temperatures des bronzes pour coussinets de chemins de fer.) H. J. French, S. J. Rosenberg, W. le C. Harbaugh and H. C. Cross. Transl. by Puech. *Revue de Metallurgie*, Sept. 1929, pages 488–502.

An abbreviated translation of the *Paper* No. 13, *Bureau of Standards Journal of Research*, September 1928. JBG

New Processes for Production of Particularly Hard and Chemically Resistant Alloys. (Neue Arbeitsverfahren zur Herstellung besonders harter und chemisch widerstandsfähiger Legierungen.) C. Sykes. *Metall*, Sept. 1, 1929, pages 139–141.

Alloying of Zr to Ni or Co yields fine and stable cutting alloys with a perfect edge. The melting point of the base metal is reduced, whereas electrical conductivity of pure nickel, hardness and resistance to corrosion and oxidation are increased. Alloys with low Zr contents (2–10%) are forgeable at red-heat. The application of the alloy is suggested for thermo-electric and resistance material. The following alloy of 65% Ni, or 25% Zr and 10% Mo melts at 1600° C. All alloys with low and high Zr-content are self-hardening. A Ni-Ta alloy with 15–10% Ta exhibited outstanding mechanical properties and strong corrosive stability. The alloy with 30% Ta is insoluble in aqua regia. Ni looses its magnetic properties by alloying with Ta. Casting and application of the alloy 69.13% Cu, 14.81% Ni, 8.64%Zn, 3.7%Al, 3.08% phosphorus-tin, 0.58% Pb and 0.06% Fe is discussed. A new German-silver which possesses remarkable strength is composed of 46% Cu, 8% Ni, 2% Mn and 44% Zn. By adding 5% of ferro-manganese (80%) the customary Cu-Zn alloys become harder and considerably stronger without losses in elongation. The following alloy is recommended: 49% Cu, 40% Zn, 5% Fe-Mn, 6% Cu-Fe-Ni-Al. EF

The Properties of Sheet Magnetic Materials. B. G. Churcher. *Electrician*, Nov. 29, 1929, pages 659–662.

Essential knowledge of the properties of the magnetic materials is necessary for the designer. These are outlined and the permeability of steels discussed. Also the effect of silicon content, and the hysteresis loss underal ternating magnetization. Curves show the relative permeability curves of steel, effect of silicon on hysteresis, illustrating the total energy losses with increasing silicon content, effect of silicon on constituent losses, and permeability curves of alloys used for instrument transformers. Magnetic leakage in permeability, and energy loss apparatus must be kept to a negligible amount. The hysteresis loss is influenced by the physical condition of the material and the permeability is influenced thereby to an even greater extent. At moderate and high flux densities, the introduction of silicon increases it. 4.5% silicon steel is used in manufacturing the cores of current transformers. Permalloy (78.5% Ni) has a permeability eight times that of 4% Si-steel. An alloy of 50% Ni, 50% Fe is receiving increased attention. The maximum permeability is 6 times that of 4% Si-steel and this is less susceptible to sensitiveness in handling. It is used in instrument transformers and in audio frequency transformers for wireless work and in the construction of choke coils. Both Ni-Fe alloys have been used in ribbon form in connection with the loading of long distance submarine cables, enabling greatly increased operating speeds to be attained. WHB

The Hall Effect, Electric Conductivity and Thermoelectric Power of the Copper-Tin Series of Alloys. E. Stephens. *London, Edinburgh & Dublin Philosophical Magazine*, Sept. 1929, pages 273–289.

The electrical resistivity, temperature coefficient of resistance, thermoelectric force, and Hall effect of the copper-tin series of alloys have been determined. The alloys were chill cast in an iron mold and the electrical resistivity at 0° C. was determined and the changes investigated after annealing. Singular points corresponding to both Cu$_3$Sn and Cu$_4$Sn are obtained in each of the curves, showing the relation between electrical resistivity, temperature coefficient of electrical resistance, thermoelectric power, Hall effect, and the concentration of one metal in the alloy. EF

Physical Properties and Methods for Some Sheet Non-Ferrous Metals. J. R. Townsend & A. L. Straw. *Bell System Technical Journal*, Oct. 1929, pages 749–805.

This paper covers an investigation which was undertaken to secure a simple and reliable method of test for sheet non-ferrous metals. An account of the Rockwell hardness tester for a preliminary inspection of sheet metals and the tensile test as the basic test to be referred to in case the Rockwell test results were near to or outside the established Rockwell limits for a given lot of material was published in 1927. This paper describes the development work reported by two previous papers. Considerable attention has been given to the Rockwell tester which, as a result of this work, has been found satisfactory for use as a specification instrument for brasses 0.020″ and thicker, when used under standardized methods of test and calibrated with standard test blocks. Other tests such as the bend test, ductility test and other hardness tests have been studied but further development work is necessary. The Rockwell hardness and tensile strength limits are given for four alloys of brass, and two alloys each of nickel silver and phosphor bronze. The physical properties of the rolling series upon which these limits were based are presented as well as experience data obtained on shipments of commercial material. Grain size limits are given for annealed brass and nickel silver sheet. For inspection purposes the grain size is estimated by comparison with the standard photomicrographs reproduced in the 1929 report of Committee E4 of the A. S. T. M. on Metallography. Refinements in the calibration of the Rockwell tester are given as well as the development of testing technique. An experimental model of a motor-driven bend test machine is described.

PROPERTIES OF FERROUS ALLOYS

Comparative Properties of Wrought Iron Made by Hand-Puddling and by "Aston" Process. H. S. Rawdon & O. A. Knight. Metals & Alloys, Aug. 1929, Vol. 1, pages 46–56.

This is a report of an investigation made by the authors at the Bureau of Standards comparing wrought iron made by hand-puddling and by the "Aston" process.

Symposium on Physical Properties of Cast Iron. Reprint from *Proc. of American Society for Testing Materials*, Philadelphia, 1929, Vol. 29, Part 2, 118 pages.

The dozen papers in this symposium, held at the June 1929 meeting, have been printed in a separate pamphlet, including the discussion. Such separate pamphlets are convenient, and their publication serves a useful purpose. No one will lug a bound volume of the A. S. T. M. Proceedings with him on a trip nor read it as he commutes to work, while he is very likely to stick a little pamphlet in his pocket to read at odd times. Hence the material in the pamphlet is far more likely to be read than if it were not separately printed. And it is worth reading. The various papers on effect of section, of composition, correlation of test bars and castings, static strength of plain and alloy iron, elastic, fatigue, impact, wear, resistance, machining and corrosion resistance properties, and on heat-treatment, have been previously abstracted in Metals & Alloys. Discussion included in the pamphlet adds interesting data from Mochel on the relation between the arbitration bar and castings of various sections, additional data from MacKenzie on elasticity and from Bornstein on wear testing. Bornstein made tractor cylinders from plain iron of about 3.4–3.5% total carbon, 0.20–0.25% combined carbon, 2.35% Si, 120–130 Brinell and from alloy iron of about 3.30% total carbon, 0.40–0.45% combined carbon, 2.40% Si, 0.50–0.70% Ni, 0.22 Cr, 145-160 Brinell. This increase in hardness did not increase the dificulty of machining. The tractors were run 20 hours with 3 lbs. of dust fed to the motor during the run. The wear on the cylinder was measured after the engine was torn down, the plain iron losing about 0.008 in. and the alloy iron about 0.006 in. with quite decent agreement among duplicates. HWG

Fatigue and Fracture. (Ermüdung und Bruch.) F. Vogel. *Metallbörse*, Sept. 1929, page 2051.

The writer reports on investigations concerning cast iron anode supports which exhibited changes under the microscope due to the heat of electrolysis of fused electrolytes. The material was only mechanically stressed by the suspended electrodes. Nevertheless fracture occurred since the graphitic carbon uniformly distributed in the initial material underwent physicochemical transformations resulting in appearance of bands. EF

Wear of Rails and Its Measurement. (Schienenabnutzung und ihre Messung.) Dr. Kühnel. *Organ für Fortschritte der Eisenbahnwesens*, Oct. 15, 1929, pages 418–423.

The paper presented before the Schweizerischer Verband für Materialprüfung, March 1929, Zurich, deals with the measurement of rail wear by means of the testing machines of Mohr & Federhaff, Amsler and Spindel, the results of which are presented in diagrams and tables. EF

CORROSION, EROSION, OXIDATION, PASSIVITY AND PROTECTION OF METALS AND ALLOYS

Recent Developments in Corrosion-Resistant and Heat-Resistant Steels. John A. Mathews. *Industrial & Engineering Chemistry*, Dec. 1929, pages 1158–1164.

This article discusses about a dozen steels in their composition, heat-resistance and corrosion-resistance, as well as specific uses. Corrosion data are given for ordinary and higher temperatures, for different concentrations of H_2SO_4, for 5% H_2SO_4 saturated with ammonium sulphate, for alternate treatment with acid and alkali, etc. The paper is extremely instructive. Some attention is given to the mechanism of scaling due to oxidation. Scale or oxide on bars is not a simple structureless oxide of iron, but long-continued exposure of steel ot high temperatures results in a scale which consists of three layers. In a 36% nickel alloy the outer layer of scale contained but 1.46% nickel, the middle layer 2.29, while the third layer contained 52.08%. Other steels, except manganese steel, showed similar variation in the layer compositions. MEH

A Zinc-Containing Lubricant for the Prevention of Corrosion. V. V Kendall. Metals & Alloys, Dec. 1929, Vol. 1, pages 281–283.

A critical abstract of an article in the Sept. 27, 1929, issue of *The Engineer* (London) which reports on an occurrence of corrosion in lubricated machine parts which was prevented by the addition of zinc oxide to the lubricant.

Rust Resisting Treatment. Ernest L. Holcomb. *Machinery*, Oct. 1929. page 125.

Small parts such as pawls, pins, etc., when hardened, quenched in oil and used without grinding resist corrosion quite well. If the surfaces must be smoothed, tumbling is preferable to burnishing or grinding as the tumbled parts do not corrode as readily as the ground parts. RHP

Protecting Aluminum and Its Alloys from Corrosion. H. Sutton. *Brass World*, Dec. 1929, pages 287–289.

An abridged report of the opening meeting of the British Electroplating Society. Various processes of anodic oxidation of aluminum and its alloys are outlined. The anodic oxidation process tends to open up and reveal any defects such as laps, seams, etc., in the metal occurring at the surfaces also to disclose any attempts to plug up blow holes, holes drilled in the wrong place, etc. The protection due to anodic oxidation is enhanced by the subsequent application of suitable paints or enamel or by a grease. A discussion follows. WHB

Corrosion of Iron; Correlation of A. S. T. M. Test Data. H. W. Gillett. Metals & Alloys, Sept. 1929, Vol. 1, page 116.

Briefly discusses the recent papers on this subject by Kendall and Taylerson, and Passano and Hayes read before The American Society for Testing Materials.

The Corrosion of Brass. Max Haas. Metals & Alloys, Oct. 1929, Vol. 1, pages 183–189.

Translation of an article from *Korrosion und Metallschutz*, Feb. 1929, pages 25–35. See Metals & Alloys, July 1929, page 26. Correction appears in Nov. 1929, page 234.

On the Rusting of Copper Steel by the Atmosphere and in the Different Waters. (Ueber den Rostvorgang gekupferten Stahles an der Atmosphäre und in verschiedenen Wässern.) C. Carius & E. H. Schulz. *Archiv für Eisenhüttenwesen*, Nov. 1929, pages 335–358.

The authors investigated in a series of carefully conducted experiments the reasons for the well-known superior corrosion resisting properties of copper-bearing steel. They investigated separately corrosion (1) in distilled water, (2) in the atmosphere of an industrial district and (3) in diluted salt solutions (artificial solutions, sea water, river water). They showed that the corrosion in distilled water starts by dissolving of iron atoms, and is followed by the solution of copper. The copper ions are finally precipitated practically quantitatively on the surface of the steel by the negative potential of the iron. The precipitated "copper patina" is the cause of the successful metal protection in atmosphere. The copper films can be made visible by interference colors. Due to the interchanging oxidation power of the solution and the re-precipitation of the copper oxide, the copper films change their location. In case of weather corrosion the conditions are similar. The scale of copper oxide–copper hydroxide below the iron oxide scale is extremely adherent and causes the high weather corrosion resistant qualities of the material. The poor behavior of copper-bearing steel in salt solutions is due to the nature of the precipitated film of copper, which is composed of fine crystals, which do not protect the surface of the material sufficiently. The authors point out that precipitation phenomena on the surface of the steel similar to those with copper-bearing material can also be observed with other alloying elements, for example with antimony, which, however, gives a very crystalline and therefore unfavorable film. Very promising results were obtained by the authors with steels bearing copper and aluminum. CK

Investigations on Cadmium Coatings. (Untersuchungen an Cadmiumüberzügen.) R. Hopfelt. *Korrosion & Metallschutz*, Aug. 1929, pages 176–180.

Corrosion attack of lactic acid, CH_3OOH, NH_3 and NaOH solution on Cd and Zn was investigated. The utilization of Zn for food is prohibited. The replacement by Cd was studied. The results gave evidence that the solution speed has to be taken into consideration. Thus acids, as CH_3COOH for instance, rapidly dissolve Cd whereas it represents a favorable protection for Fe against most of the customary food-stuffs. Velocity of dissolution in distilled water, city water of Hamburg, water saturated with CO_2, artificial sea-water with 3.7% NaCl was determined after 88, 152 and 208 hours. Attack of beef-tallow and margarine was determined. Favorable results were obtained with a Cd-Sn coating. The solution speed of Cd was found to be very low so that the utilization in the food industry is recommended in addition to the application as an anti-rust coating. EF

On Corrosion and Rusting of Plain and Alloyed Cast Iron. (Ueber die Korrosion und das Rosten von unlegiertem und legiertem Gusseisen.),– P. Kötzchke & E. Piwowarsky. *Korrosion & Metallschutz*, Aug. 1929, pages 174–176.

Corrosion attack of cast iron, plain and alloyed was investigated in 1/2 n. HCL; 1/5 n. CH_3COOH; 25% KOH solution and molten caustic alkali 1/10 n. NaCl solution; 1/10 n. $(NH_4)_2SO_4$; and 20% $KHCO_3$ solution. EF

STRUCTURE OF METALS AND ALLOYS

Metallography and Macrography

A New Automatic Metallographic Polishing Machine. S. Epstein & J. P. Buckley. Metals & Alloys, Nov. 1929, Vol. 1, pages 226–231.

The authors describe an automatic polishing machine developed by them at the Bureau of Standards.

A Contribution to the Knowledge on the System Nickel–Iron. G. F. Sizoo & C. Zwikker. Metals & Alloys, July 1929, Vol. 1, pages 29–30.

Translation of an article from *Zeitschrift für Metallkunde*, April 1929, pages 125–126. See Metals & Alloys, Aug. 1929, page 74. Correction appears in November issue, page 234.

Experimental Data on the Equilibrium of the System Iron Oxide–Carbon in Molten Iron. A. B. Kinzel & J. J. Egan. *Technical Publication* No. 230, *American Institute of Mining & Metallurgical Engineers*, 9 pages.

See Metals & Alloys, Jan. 1930, page 340.

The Measurement of Graphite Size in Cast Iron. A. L. Norbury & L. W. Bolton. *Bureau Report* No. 56, *Bulletin British Cast Iron Research Association*, pages 189–191.

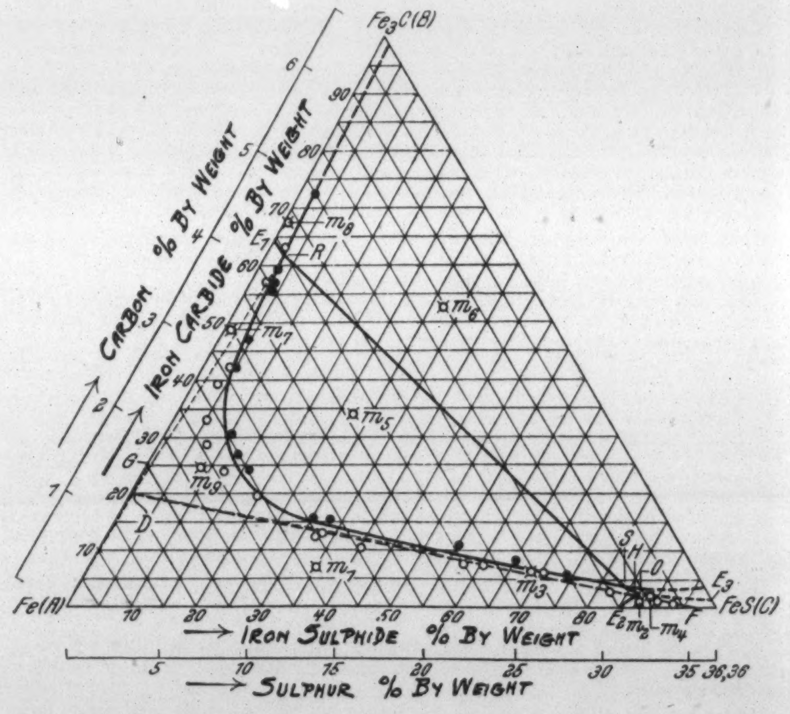
The authors consider the desirability of accurately defining graphite size and discuss the difficulty of accurately measuring lengths of the graphite flakes. Photomicrographs of different sizes of graphite structures are included.

The System Cadmium–Mercury. R. F. Mehl & C. S. Barrett. *Technical Publication* No. 225, *American Institute of Mining & Metallurgical Engineers*, 16 pages.

The crystal structure of Hg was found to be rhombohedral at −46°, whereas a new rhombohedral solid solution terminal to pure mercury and a heterogeneous field separating this from the face-centered tetragonal field previously discovered could be determined in the mercury-rich Cd-Hg alloys. A peritectic reaction was furthermore found near the mercury ordinate. The solid solution terminal to pure mercury probably extends to 3.5 atomic % Cd, the heterogeneous field from 3.5–12% Cd and the intermediate solid solution from 12% Cd to higher concentrations in Cd. A new transition point was found in the latter field. EF

Contribution to the Knowledge of the Sulphur–Iron–Carbon System. (Beitrag zur Kenntnis des Systems Schwefel-Eisen-Kohlenstoff). Heinrich Hanemann & Artur Schildkötter. *Archiv für Eisenhüttenwesen* Dec. 1929, pages 427–435; *Stahl und Eisen*, Jan. 9, 1930, pages 42–43.

The investigation is based on the well-known Fe-Fe_3C diagram and on the Fe-FeS diagram of Becker (Doctor thesis, Breslau 1919). According to the literature, the solubility is incomplete in Fe-C alloys with higher S in the liquid state. This was found to be correct. The range of the incomplete solubility was detected in the ternary system. The ternary eutectic was found at a temperature of 978° C. and at an approximate composition of 10.5% Fe, 2.5% Fe_3C, 87.0% FeS. The diagram is based on the results of metallographic and thermal analyses. CK&GN



Structure and X-ray Analysis

Causes of Tip Formation on Deep Drawn Shells. Arthur Phillips & Gerald Edmunds. *Metal Stampings*, Sept. 1929, pages 703–760.

Abstract of paper read before the American Society for Testing Materials, June 24–28, 1929. See "An X-ray Study of Copper which Showed Directional Properties on Cupping," Metals & Alloys, Dec. 1929, page 287. MS

Note on Crystal Structure of the Alpha Copper Tin Alloys. Robert F. Mehl & Charles S. Barrett. *Mining & Metallurgy*, Aug. 1929, page 389.

See Metals & Alloys, Jan. 1930, page 339. EF

Note on the Possibility of Enlargement by X-rays. Frederick Sillers, Jr. Metals & Alloys, Nov. 1929, Vol. 1, pages 225, 236.

A method for enlarging the image of an object in radiography is briefly described.

X-ray Examination of Aluminum at High Temperatures. A. J. Alichanov. Metals & Alloys, July 1929, Vol. 1, page 30.

Translation of an article from *Zeitschrift für Metallkunde*, April 1929, page 127. See Metals & Alloys, Aug. 1929, page 75.

X-ray Metallography in 1929. George L. Clark. Metals & Alloys, July 1929, Vol. 1, pages 14–17; Aug. 1929, pages 57–68; Sept. 1929, pages 98–111; Oct. 1929, pages 153–161; Nov. 1929, pages 206–221.

The nature of X-rays. Radiography. The Diffraction of X-rays by Metals and Alloys. Experimental X-ray Diffraction Methods. Results of Analysis of Ultimate Crystalline Constitutions of Metals. Analysis of Alloy Systems. The Determination of Grain Size, Internal Strain, Purity and Other Properties. Analysis and Control by X-rays of Heat Treatment and Recrystallization. The Structure of Electrodeposited Metals. Practical Applications of X-ray Methods to Problems of Metallurgical and Mining Industry.

On the Cast Texture of Metals and Alloys. **(Ueber die Gusstextur von Metallen und Legierungen.)** F. C. Nix & E. Schmid. *Zeitschrift für Metallkunde*, Sept. 1929, pages 286–292.

The paper abundantly illustrated with X-ray photographs and micrographs of cast metals and alloys, attributed the development of regular structure to the anistropy of crystals and explains the methods of determining crystal arrangement, principally by means of X-rays. The investigated single-phase systems, metals and solid solutions as well as binary eutectics are discussed. The authors state that the texture in many cases could be described as fibrous structure with a simple crystallographic direction parallel to the longitudinal axis of the radial crystals, except hexagonal metals as for instance Zn and Cd. The following table summarizes the investigations:

Metal	Atomic arrangement	Parallel to longitudinal direction of crystals is:	Closest packed direction.
α(δ)-Fe-Si	Cubic	[100]	1. [111]
β = brass	Body centered	[100]	2. [100]
Al	Cubic, face centered	[100]	1. [110] 2. [100]
Cu			
Ag			
Au			
Pb			
α-brass			
β-Sn	Tetragonal	110]	1. [001] 2. [111] 3. [100] 4. [101] 5. [110]
Mg		$[10\bar{1}0]$	1. $[10\bar{1}0]$
Zn	Hexagonal, close	[0001]	1. $[10\bar{1}0]$
Cd	Packed	perpendicular	
Bi	Rhombohedral	[111]	1. [101]

The investigation of the eutectic Al-Si showed that only Al appears in the characteristic cast structure whereas Si is chaotically orientated. In case of Cd-Zn both constituents superpose. EF

The Arc Spectrum of Arsenic. W. F. Meggers & T. L. deBruin *Bureau of Standards Journal of Research*, Nov. 1929, pages 765–781.

Metallic arsenic was vaporized in graphite or copper arcs and the line emission spectrum was investigated throughout the entire range accessible to photography with concave grating and with quartz prism spectrographs. The measured wave lengths range from 1889.85 to 10,023.98 A. U. The spectrum is relatively simple but difficult to analyze because many important lines lie either in the far ultra-violet or in the infra-red. The new data (vacuum wave numbers, estimated relative intensities, and self-reversal of certain lines) have made possible a fairly complete analysis of the As_I spectrum. Forty-two levels have been identified; they include practically all of the spectral terms arising from the addition of a 4p, 5s and 4d electron to the s^2p^2 configuration of the As^+ ion. The normal state is represented by a $^4S_2$ term for which the absolute value is estimated to be 80692.72, corresponding to an ionization potential of about 10 volts. Combinations of the identified terms account for 100 observed As_I lines, ranging in wave length from 1574.7 to 10,614.0 A. U., the observations being supplemented by two infra-red lines detected radiometrically by Randall and 19 lines in the Schumann region obtained with a fluorite spectrograph in vacuo by L. and E. Bloch.

Detection of Lattice Distortion in Metals by X-rays. **(Ein Röntgenographischer Nachweis von Gitterstörungen an Metallen.)** J. Hengstenberg & H. Mark. *Naturwissenschaft*, June 14, 1929, page 443.

The authors try to determine deformations by measuring the diminution of intensity of the Debye-Scherer lines with increasing deflection angles. A displacement of part of the atoms out of the symmetric arrangement diminishes the interferences of large deviation angles to a greater extent than those of smaller deviations. The authors collected in a table the relation of intensity of (200) to intensity of (400) of unworked and annealed metals and of worked (rolled) metals (Ta, W, Mo) The ratio of 1/200 : 1/400 indeed increases due to working of the metals. The deviation of the atoms from normal location is 1/150 of the space lattice. EF

X-ray Investigations on the Nitrides of Manganese. **(Röntgenuntersuchungen über die Nitride des Mangans.)** Gunnar Haegg. *Zeitschrift für Physikalische Chemie*, Aug. 1929, Sec. B, pages 346–370.

An X-ray analysis has been made of manganese nitrides which were made by nitration of manganese with ammonia. After describing previous investigations it was shown that there exist 4 phases of nitrides. The phase lowest in nitrogen is face-centered tetragonal and exists only at high temperature. The structure of the next 2 phases are of the type of very dense cubic respectively hexagonal spheric accumulations and are entirely analogous to 2 phases in the system Fe–N. The phase highest in nitrogen is again face-centered tetragonal. The diagram of the system Mn–N is discussed, and many tables and diagrams explain the results. Ha

Rolling and Re-crystallization Texture of Regularly Surface-centered Metals. **(Walz und Rekristallisationstextur Regular-flächenzentrierter Metalle.)** v. Gieler & G. Sachs. *Zeitschrift für Physik*, 1929, Vol. 56, No. 7–8, pages 477–502.

Communication from Kaiser Wilhelm-Institut für Metallforschung, Berlin-Dahlem. Based on numerous excellent X-ray photographs the authors discuss the determination of the structure of rolled materials; the so-called pole-figures of brass, aluminum, copper, nickel, constantan and gold are described and the location of the crystals illustrated. Certain complex recrystallization textures in silver and brass are explained. Ha

PHYSICAL, MECHANICAL AND MAGNETIC TESTING

The Fractures Occurring in Iron at Low Temperatures. **(Ueber den Bruchvorgang in Eisen bei tiefen Temperaturen.)** F. Sauerwald & K. A. Pohle. *Zeitschrift für Physik*, 1929, Vol. 56, No. 7–8, pages 576–578.

Whether cold-brittleness at temperatures below 0° C. bears a relation to the fracture of grain-boundaries was investigated on large iron crystals. It was shown, however, that under the existing conditions, grain-boundary fracture never takes place, but that, at sufficiently low temperature, a fracture of the individual crystals occurs without deformation. The tests have been carried out at temperatures as low as −170° C. Ha

Heat Effects in the Elongation of Brass Crystals. **(Wärmeeffekte bei der Dehnung von Messingkristallen.)** M. Masima & G. Sachs. *Zeitschrift für Physik*, 1929, Vol. 56, No. 5–6, pages 394–396.

The increases in temperature occurring after slight elongations can be used as a measurement of the energy converted into heat. Ha

Destructive and Non-Destructive Tests of Welds. J. R. Dawson & A. G Kinzel. *Paper before the 30th Annual Convention of the International Acetylene Association*, Chicago, Ill., Nov. 13–15, 1929.

Destructive tests, such as the tensile test, the bend test, fatigue, Izod and hardness tests are described and the application of test results to engineering design given. The non-destructive tests such as hydrostatic tests, those made with stethoscope and X-ray, electrical resistance and magnetic tests are discussed, and a short survey given of the progress of welding. MLM

On the Relations of Permanent Bending-strength to the Static Strength-values. **(Ueber die Beziehungen der Dauerbiegefestigkeit zu den Statischen Festigkeitswerten.)** W. Herold. *Zeitschrift Vereins Deutscher Ingenieure*, Sept. 7, 1929, pages 1261–1266.

These tests were made in order to determine whether the permanent bending strength can be derived from the values of the tensile strength test. The author found that a general equation $\sigma_D = -a\sigma_B^2 + b\sigma_B$ is most suitable for a conversion. Also, the computation of permanent strength from flow-limit, fracture-limit, and the mean value of both, gives fairly good results. For each kind of steel a characteristic line of mean values can be computed for the permanent strength in relation to the fracture-strength. The line of mean values is a parabola. Ha

Critical Impact Values. **(Kritische Kerbzähigkeitswerte.)** W. Kuntze *Metallwirtschaft*, Oct. 7, 1929, pages 1011–1017.

The author critically discusses the influence of sample, machine, temperature and material upon the magnitude of determined impact values. A certain range occurs in which a break of impact strength takes place due to several known influences which, however, do not yield satisfactory explanations and conclusions in regard to the behavior of the material. The author believes, based on a wealth of investigations that 2 factors mainly exert a dominating influence: (a) the resistance to deformation which is dependent on shape, material, velocity and temperature and (b) the resistance to separation which only depends on the material or strictly speaking on the stress during working. The influence of the manner of necking upon the fluctuations in impact values is considered. The author not only proposes whole sets instead of single tests, but urges standard methods. In the case of a limited number of tests the relation between impact value and necking of the statically tested standard tensile bar should be involved in the investigation. Based on large numbers of experiments, the author states that necking of the compression zone of the sample is necessary. The detection of the range of break-down by means of an accelerated test is given in the paper which contains 23 illustrations and 38 references. EF

A New Testing Machine for Investigation of Materials under Alternating Often Repeated Bending Stress. **(Eine neue Prüfmaschine zur Untersuchung der Werkstoffe bei wechselnden, oftmals wiederholten Biegebeanspruchungen.)** E. Dorgerloh. *Metallwirtschaft*, Oct. 7, 1929, pages 986–990.

The fatigue testing machines are classified and the new apparatus introduced in which the testing bar is mounted vertically clamped at one end and stressed at the free end. The testing machine is electrically driven at 3000 r. p. m. The maximum load is 20 kg. which corresponds to 135,000 lbs./in.^{2} in the smallest cross section. A circuit breaking device stops the testing machine after fracture occurs. The original publication must be consulted for further details of the electrical-acoustic and optical devices for measuring the deflection of the test rod. EF

The Torsion Test. **(Der Verdrehungsversuch).** Fr. Meyer. *Siemens Zeitschrift*, Aug. 1929, pages 496–499.

Torsion testing, static and dynamic, is discussed. Formula, calibration and methods of the investigations are given. The rotation-vibration-testing machine according to Foeppl-Busemann is considered. EF

Precision Permeability Measurements on Straight Bars and Strips in the Region of High Permeability. C. E. Webb & L. H. Ford. *Journal Institution of Electrical Engineers*, Nov. 1929, pages 1392–1316.

The construction of a yoke apparatus to give magnetizing forces up to H = 3000 on straight samples 20 to 25 cm. long, and up to H = 5000 on samples 8 to 10 cm. long is described. The method of measuring the magnetizing force by means of search coils is used, and an examination is made of its applicability to strip and bar samples mounted in the yoke apparatus. It is found that, below H = 15, large errors result from the leakage taking place along the length of specimen under test. The conditions for satisfactory compensation for this leakage are determined and the method is then shown to give good agreement with tests on rings of similar magnetic properties. In part 2 the effect of stress in the magnetic specimen is considered. Stress may be caused by clamping in the case of bars or by windings on rings or strips of sheet material, and it is shown that such stress may have a very large effect on the results of magnetic measurements. A further source of error in tests in strip samples is found to be the reluctance between the strips. Conditions of testing to obviate both these sources of error are indicated.

Recent Material Testing Machines. **(Neuere Werkstoffprüfmaschinen.)** F. Bruckner. *Zeitschrift der Osterreichischen Ingenieur und Architektenvereins*, Oct. 11, 1929, pages 428–429.

Testing machines of modern design for hardness and torsion testing are considered. EF

ELECTRO-CHEMISTRY

Electroplating

A New Chromium Plating Test. E. M. Baker & W. L. Pinner. *Brass World*, Nov. 1929, pages 269–272.

The bent cathode test and some observations on chromium plating are given. The cathode used was sheet copper 1" × 2½" and the anode is a freshly cleaned piece of sheet lead. A diagram of the experimental apparatus and charts show: (1) the effect of varying chromic acid concentration on optimum sulphate ratio, (2) the effect of trivalent chromium on optimum sulphate in a 2.5 molar chromic acid chromium plating bath, and (3) the effect of iron on optimum sulphate in such a solution. The test was devised for the control of a bath for plating of bumper bars and is claimed to be rapid, simple and to permit quick adjustment of the sulphuric-chromic acid ratio where the article to be plated is of simple design like bumper bars. WHB

Chromium Plating. **(Verchromung.)** W. Birett. *Umschau*, Sept. 9, 1929, pages 714–715.

The importance of the Ni intermediate layer on brass before chromium plating is considered. The utilization of chromium plating in manufacture of molds for pressed glass is emphasized. EF

Electro-deposition of Copper from Alkali-Solutions. **(Die elektrolytische Kupfergewinung aus Laugen.)** F. Vogel. *Metallbörse*, July 6, 1929, pages 1489–1490.

The layout of a plant with an output of 100 tons of electrolytic copper in 24 hours is given. EF

The Nickel Chromium Process. **(Das Nickel-Chrom-Verfahren.)** W. Pfannhauser. *Korrosion & Metallschutz*, Aug. 1929, pages 190–192.

General outline of chromium plating is given: commercial processes, application of Ni as intermediate layer, brass as base metal, economy, peeling off of the coating, acidity of bath, influence of H_2, thickness of coating and practice of the Langbein-Pfannhäuser Works. EF

Commercial Zinc Electrolysis. **(Die technische Zinkelektrolyse.)** G. Eger. *Siemens Zeitschrift*, Aug. 1929, pages 476–496.

History, patents, outline with data from plant operation of various companies and economical calculations are given in this well illustrated paper. The contribution of the Siemens Works to the development of electrolytic deposition of Zn is emphasized. EF

Cadmium as a Rust Protector. (Cadmium als Rostschutzmittel.) W. Peters. *Metall*, Aug. 18, 1929, pages 132–133.

According to Richter a coating at 4–5 volts and 40° C. can be secured. Stübing covers cast-iron electrolytically with Cd-Zn or Cd-Cu. The coating films which can be obtained in a few minutes show a brilliant appearance and exhibit a thorough protection against rust. EF

Silver Plating Solutions. *Electrical Review*, Aug. 2, 1929, pages 214–215.

Includes discussion. Report of a meeting of the Electroplaters' and Depositors' Technical Society, at which was read a paper by E. B. Sanigar entitled "Comparison between Sodium Cyanide and Potassium Cyanide Silver-plating Solutions." In England there is considerable prejudice against the use of the sodium salt, which is said to result in an inferior deposit. The author carried out some tests in trade deposits and had them finished by experienced finishers. On the basis of finish obtained and the loss during finishing. It was concluded that there was no difference between the sodium cyanide and potassium cyanide solutions. MS

Electrometallurgy

Construction of Apparatus for Electrolysis of Fused Electrolytes. (Zur Konstruktion technischer Apparate für die Schmelzflusselektrolyse.) P Drossbach. *Metall & Erz*, Oct. 1929, pages 514–516.

The theoretical investigation considers conditions of variable distance of electrodes. EF

The Production of Beryllium. (Die Gewinnung von Beryllium.) *Zeitschrift Vereins Deutscher Ingenieure*, Sept. 7, 1929, page 1282.

From "Wissenschaftliche Veröffentlichungen aus dem Siemenskonzern." Beryllium is produced similarly to aluminum by electrolysis of the molten salts at a temperature of 1285° C.; dense metallic reguli are obtained in this way. It is difficult to work at this temperature since almost all salts evaporate hereby. The electrolyte is formed of beryllium oxyfluoride with an addition of barium fluoride to increase the electric conductivity. The metallic beryllium can easily be made from this mineral. The furnace used in this process and also the process itself is described in detail. The process is continuous and gives a metal of 99.5% purity. Energy consumption for 1 kg. of beryllium is about 100 kw-hr. against 30 kw-hr. for aluminum. If heavy metals are added in form of powder, beryllium alloys can be obtained directly in form of rods. Ha

Refining of Magnesium. (Die Reingung des Magnesiums.) F. Vogel. *Metallbörse*, Feb. 27, 1929, pages 453–455.

Purification of Mg electrolytically produced from $MgCl_2$, by means of a mixture of alkaline-earth metal chlorides, fluorides and MgO, designated as Elrasal. EF

METALLIC COATINGS OTHER THAN ELECTROPLATING

Zinc Coatings by Spraying and Sherardising. (Zinküberzüge durch Spritzen und Sherardisieren.) F. Roll. *Metall*, May 12, 1929, pages 73–75.

The author gives details on the coating of metals with Zn by means of the spray method and by sherardising. EF

How is Iron Coated with Cadmium? (Wie überzieht man Eisen mit Kadmium? Neues Verfahren.) W. Peters. *Metall*, Aug. 18, 1929, page 132.

The method consists of immersing the objects into liquid Cd having a bath temperature of 360° C. The coatings adhere firmly and the coated material can be welded, turned, bent, etc. An alloy of 83% Cd and 17% Zn is particularly recommended. EF

A Few Thoughts on Galvanizing. W. H. Spowers, Jr. *Wire and Wire Products*, Dec. 1929, pages 403–406.

This is a general consideration of the whole galvanizing process, with a special reference to deep-kettle installation and the positive control of coating thickness. MLM

Zinc Coating Failures in Galvanizing Traceable to Many Causes. Wallace G. Imhoff. *Iron Trade Review*, Aug. 22, 1929, pages 451–452, 455–456.

Outlines causes of peeling and flaking. Some of these are using high-silicon steel with loose skin on it, very hard, brittle, close-grained steels, or those finished too smooth; dirty pickling solutions and steel; poor grades of zinc; too high or too low temperature of metal bath; too long or too short submersion time; coating too heavy; water quenching too soon after removal from hot bath; and piling too hot. MS

The Metal Coating of Small Iron Parts. (Das Metallisieren von Klieneisenzeug.) H. Kalpers. *Dinglers polytechnisches Journal*, May 1929, pages 100–102.

The operation of the new inclined drum for metal spraying of the Metallisator Co., Berlin is described. The corrosion tests of the Vereinigte Stahlwerke, Dortmund with molten zinc coated and spray coated iron samples are reported and the investigations of Siemens & Halske and the Technische Hochschule Karlruhe along the same lines are reviewed. EF

Protection of Steel from Corrosion by Non-Ferrous Metals. *Metal Industry*, London, Nov. 29, 1929, page 518.

Describes a process of spraying molten metal directly on steel by means of a "pistol." This process has been developed by the Metals Coating Co., Ltd., in conjunction with associated concerns. VSP

Simplified Tinning. *Automobile Engineer*, Oct. 1929, pages 383–384.

A tinning compound called "Soldo" is produced by the Soldo Company, Silician House, Southampton, Row, London. It is claimed that this product will tin any metal except aluminum. No acid or greasy fluxes are necessary and the tinning has been successfully done over a coat of rust. The surface to be plated is heated with a blow-torch and the "Soldo" is sprinkled over the surface, which when wiped presented a well tinned surface. The actual content of the compound is a secret. RHP

Zinc Economy in the Hot Galvanizing Process. Wallace G. Imhoff. *Metal Cleaning & Finishing*, Sept. 1929, pages 461–464.

First place to start zinc economy is by a reduction in the amount of by-products produced, which may be accomplished with suitable drossing equipment. The drossing spoon should have fairly small holes, and as many as possible and practical, and they should be not over an inch apart. High heat intensity on the sides of the kettle should be avoided. MS

INDUSTRIAL USES AND APPLICATIONS

Superheated Steam Resistant Material in the Machinery of the "Bremen." (Heissdampfbeständige Werkstoffe bei der maschinellen Einrichtung der "Bremen.") K. Springorum. *Deutsche Motor Zeitschrift*, Oct. 1929, pages 514–516.

The author refers to a special Ni-alloy "Admiro" for steam turbine parts. Microphotographs of the alloy are included and the significance of the constituents discussed. EF

Nitrided Steels for Cylinder Liners and Crank Shafts. (Nietrierstähle für Zylinderlaufbüchsen und Kurbelwellen.) H. Bellag. *Auto-Technik*, May 15, 1929, pages 10–11.

The practice of nitriding automobile and airplane parts in the Hispano Suiza Co. is described. Analysis of steel: 0.35% C, 1.6%Cr, 1.2% Al. EF

Steels for Automobiles and Aeroplanes. W. H. Hatfield. *Automobile Engineer*, Nov. 1929, pages 464–474.

A paper before the Institution of Automobile Engineers. Gives several references in the footnotes. Reviews the progress of the manufacture of steel for automobiles and aeroplanes since 1921. Discusses the properties and composition of steels for valves, springs, frames, bodies and tubes. Contains material on nitralloy and rustless steels. The appendix, pages 469–474, contains suggested specifications for the steels to be used in the various parts of the automobile and aeroplane. RHP

Tantalum Proves Economical for Calorimeter Body. G. C. Maier. *Chemical & Metallurgical Engineering*, Sept. 1929, page 553.

A new type of precision calorimeter for studying the dissolution of metals and oxides in strong acids is constructed of Ta and Bakelite. This has proved ideal with respect to corrosion and also decidedly economical. MS

New Automotive Products at the National Metal Show. Herbert Chase. *American Machinist*, Oct. 3, 1929, pages 593–594.

Use and importance of high-chromium and stainless steels is increasing rapidly. Automobile manufacturers are using from $2^1/_2$ to 15 lbs. of these per car. Nitrided steel is being used for cylinders, crankshafts, timing gears, cam shafts, clutch shafts and disks, etc. Several new alloys and their uses are mentioned. RHP

Strides Made in Aluminum Industry. *Iron Age*, Jan. 2, 1930, page 53.

Production of aluminum alloy structural shapes opened a new field in the motor truck and street car manufacturing industries. Structural shapes are also used in crane construction. The aircraft industry's increased use of aluminum is attributed to the growing favor of all metal planes. Other applications of aluminum are in the oil fields, owing to its resistance of hydrogen sulphide and in the ornamentation of exterior and interior of buildings. VSP

Aluminum Screens; Designs for Severe Service. E. P. Balch. *American Machinist*, Nov. 14, 1929, pages 811–813.

Describes an aluminum screen and screen frame. It is practically noncorrosive, is more durable and less conspicuous than ordinary screen. RHP

Platinum-Group Metals in Product Design. Frederick E. Carter. *American Machinist*, Nov. 14, 1929, pages 822–824.

This group consists of the metals platinum, iridium, osmium, palladium rhodium and ruthenium. These metals are very highly resistant to corrosion. Because of this they are used for surgical instruments, electrical contact points, precision-type resistances, standard weights, thermocouples and like instruments. These alloys are useful for plating instruments, fine hardware and jewelry. Cheaper alloys of the platinum group using copper, cobalt or nickel are now available and are being used for many things. RHP

Metals in Aircraft Construction. John F. Hardecker. *American Machinist*, Oct. 10, 1929, pages 629–632.

Discusses the increasing use of light metals and their alloys in the aircraft industry. Duralumin is the outstanding metal for wings and braces. Magnesium and aluminum are used in engine construction. Metals adapted to welding, and stainless steels are taking an important place in aircraft construction. RHP

Silicon Steel for Structural Work. *Engineering Progress*, Nov. 1929, pages 305–307.

Silicon steel contains up to 1% of silicon, has an average manganese content of 0.8% and carbon content varying between 0.12 and 0.2%. Due to its high elastic limit it is well suited to structural work. Cost of production is slightly higher than ordinary structural or carbon steel. RHP

Extruded Metals in Architectural Work. H. Huff. *Wire & Wire Products*, Jan. 1930, pages 10–11.

Address before the National Association of Ornamental Iron, Bronze and Wire Mfrs., St. Louis. The author discussed the necessity for care in cleaning alloys containing much copper, recommending for this purpose pumice and turpentine. He says care must be taken in the installation of white metals. MLM

HEAT TREATMENT

Heat Treatment of Various Types of Iron Coastings. *Fuels & Furnaces*, Aug. 1929, pages 1173–1174, 1182.

Report of Committee on Cast Iron of the American Society of Testing Materials presented at a recent annual meeting. Gives information obtained by means of a questionnaire sent to about 300 manufacturers. MS

Metallurgy Discloses Value of Alloys in Airplane Manufacture. C. B. Phillips. *Iron Trade Review*, Aug. 8, 1929, pages 325–327.

Heat treating facilitates the use of lighter weight alloy steels for construction of engines and fuselage by imparting greater strength. Describes the practice of the Fairchild Airplane Mfg. Corporation with regard to the composition of the steels used, and treatment given. This company uses more than 10 different alloy steels, including chrome-vanadium steels. MS

Change of Austenite into Martensite. Dartrey Lewis. *Heat Treating & Forging*, Aug. 1929, pages 991–994, 998.

Includes 16 references. Paper presented before Iron and Steel Institute. Investigation of the case of an 0.8% carbon steel. The steel in the form of wire was heated to 1500° F. and quenched in salt baths at different temperatures. During cooling in air, records were made of changes in length and of magnetic properties. The results indicated that quenching at 450° F. produced stable austenite, which changed to martensite on cooling. The austenitic state is stable in this steel at 450° F. for at least five minutes. When the austenite decomposes below 450°, the reaction is rapid and hard martensite is produced. From 450–600°, the decomposition is comparatively slow and the product has a martensitic appearance. The needles, though, are very large, and the hardness is low. MS

Accurate Heat-Treating in the Small Shop. Fred H. Colvin. *American Machinist*, Nov. 28, 1929, pages 877–878.

Accurate heat treatment requires good furnaces with heavy walls to retain the heat. Both quenching, baths and hardening rooms must be kept clean. Gives a few suggestions for economical arrangement of handling equipment. Gives a typical treatment for cutting pliers. RHP

Tempering and Coloring Axes. Wirt S. Scott. *American Machinist*, Oct. 24, 1929, pages 707–709.

Electric furnaces for hardening and tempering of axes have been installed in the plant of the Warren Axe Company, Warren, Pa. The heat of these furnaces is accurately controlled through 2 thermocouples in each furnace 1 in the bath and 1 in the chamber. A system of lights, controlled from the pyrometer, informs the operater as to the condition of the furnace and the speed at which he should work to hold the temperature at the desired point. Two men are turning out more work than was formerly done by 5 men using fuel furnaces. RHP

Electric Heat Treating Effects Large Savings for Salisbury Axle Co. Wirt S. Scott. *Electric Journal*, Jan. 1930, pages 46–48.

"The replacement of oil-fired furnaces by continuous pusher-type electric furnaces resulted in improvement of quality; greater production in less floor space; almost complete elimination of rejects; better working conditions; and a material reduction in labor, tools and maintenance." WHB

Heat Treatments for Rifle Parts. J. B. Nealey. *Iron Age*, Nov. 28, 1929, pages 1435–1438.

Discusses various processes by which rifle parts are heat treated. Simplification of manufacture as carried out at the Springfield Arsenal. Specifications for these are the same as the S. A. E. numbers 1020, 1120, 1095, 1350 and 2340. Rifle barrels are either forged, machined from round stock or rolled. Describes carburizing and parkerizing practice and methods of coloring the barrels. Gives results of series of tests conducted which included rolling barrels at temperatures from 1200–1500° F., and heat treated afterwards. VSP

Annealing

Malleable Iron—Short Cycle Anneal. I. R. Valentine. Metals & Alloys, Nov. 1929, Vol. 1, pages 233–234.

Method used by General Electric Company is briefly described.

Bright Annealing. *Electrician*, Nov. 29, 1929, page 675.

In the Grunewald method the annealing pot is rendered airtight when the maximum temperature is reached. The pot does not stand on the bottom of the furnace but is suspended from the rim at the top, the charge is not laid directly in the pot, but on a special tray suspended from the cover by means of rods. Casings may be made of 6–8 mm. boiler plate instead of making them 20–30 mm. thick out of cast steel or special plates. Reduction in the dead weight results in 15–20% reduction in current consumption and the thin walls offer less resistance to the passage of heat, increasing the productive capacity of the furnace. The cost of repairing a Grunewald pot is barely ¼ that for a cast steel pot which is wholly within the heating chamber. Cooling is done in a pit where the pot cools in 12–20 hrs. WHB

Case Hardening and Nitrogen Hardening

Selective Case Hardening of Locomotive Parts. Franz Bermann. *American Machinist*, Oct. 17, 1929, page 673.

Describes a method of case hardening bolts or parts selectively, so that certain surfaces may be machined afterward. The parts to be machined are left slightly larger than they are to be when finished. The part is carburized and allowed to cool in the pot. The larger part is then turned down to the required size. The part is then heated to hardening temperature and quenched in water. RHP

Present and Future of Nitriding. V. O. Homerberg. *Iron Age*, Jan. 2, 1930, pages 52–53.

The process was introduced into this country about 3 years ago. First great accomplishment in steel manufacture was the introduction of predetermined amount of aluminum. Next step was the manufacture of aluminum containing steels. Several problems have been solved during 1929, which have greatly enhanced the knowledge of nitriding. Many new developments are predicted during 1930. VSP

A New Method of Testing the Depth of Case on Carburized Steel. F. A. Firestone & E. J. Abbott. Metals & Alloys, July 1929, Vol. 1, page 18.

Method and apparatus devised for testing the depth of case briefly described.

Recent Progress in Case-Hardening. (Neuere Fortschritte auf dem Gebiete der Einsatzhärtung.) A. Jaeschke. *Metall*, Aug. 25, 1929, pages 135–137.

The types of case-hardened steels did not change materially. Boxes made of Nichrome (65–70% Ni, 2.5% Fe, balance Cr with traces of Al and Mg) exhibited better service than those of iron or steel. The best results were obtained with Al-bronze. As carburizing material a mixture of 60% C and 40% $BaCO_3$ is given. The copper plating of objects submitted to case-hardening is described and both determinations of the case by alcoholic $CuCl_2$ or by surface oxidation on heating are given. EF

Influence of Nitrogen on Special Steels and Some Experiments on Case Hardening with Nitrogen. Shun-Ichi Satoh. *Technical Publication* No. 260, *American Institute of Mining & Metallurgical Engineers*, 19 pages.

A review of more important publications on the nitriding process applied to special steels, the author gives his own investigations regarding the influence of Cr, Ti, Al, Mn, Mo, Zr, W and Ur in alloy steels exposed to the influence of NH_3 at 560 and 580° C. The increase in Brinell hardness was examined. The hardest layers could be secured by Al and Ti. Some of those steels were tested in tension. The influence of surface treatment is revealed by microphotographs. EF

Aging

The Effect of Aging and of "Blue-Brittleness" on the Toughness of Low-Carbon Steel. L. R. van Wert. Metals & Alloys, Oct. 1929, Vol. 1, pages 172–175.

A critical abstract of a report of the Forschungs-Institut der Vereinigte Stahlwerke Aktiengesellschaft by A. Kühle. The original investigation is concerned principally with the effect of aging and "blue-brittleness" on the toughness of low-carbon steel as measured by the repeated blow and notched bar impact tests.

JOINING OF METALS AND ALLOYS

Soldering

Soldering Metal to Porcelain is Now Practicable. D. A. Johnson & W. K. Naylor. *Electric Journal*, Dec. 1929, pages 566–567.

A thin coating of metal is intimately fixed to the porcelain and the metal parts of the point then soldered to it. The glazed surface of the porcelain is carefully cleaned, painted with a metal glaze and the piece refired. Advantages of the application include: it is oil, gas and moisture tight, a certain amount of flexibility is secured, and solder takes up differences of expansion in the assembled units. The solder metal-porcelain point is compact, strong, withstands wide ranges of temperature change, and is neat in appearance. WHB

How to Silver Solder Metal Parts. *Oxy-Acetylene Tips*, Nov. 1929 pages 81–82.

The superiority of silver solder over bronze solder for radio, electrical, and automobile apparatus is discussed. The technique of its application is given. MLM

A Solder for Stainless Steels. (Ein Lot für rostfreie Stähle.) A. Pomp & L. Walther. *Metallbörse*, Sept. 1929, page 2053.

The composition range of the solder is given as follows: Mn 30–70%, Cu 10–60%, Ni 10–50%, with melting points between 850 and 1050° C. Very good results are obtained with 40% Mn, 50% Cu and 10% Ni which melts at 900° C. The color is equal to that of stainless steel and can be modified by additions of Co, Fe, Cr, Ag, Al, Zn, etc., with increasing amounts not over 30%. As flux the following composition is recommended: 45% alkaline borate, 25% alkaline carbonate, 25% alkaline chloride and 5% titanium hydroxide. The latter can be replaced by ammonium molybdate or by a mixture of those metal salts. EF

How is Lead Welded? (Wie wird Blei Geschweisst?) R. W. Mülker. *Apparatebau*, May 31, 1929, pages 127–128.

The author reviews the main viewpoints which must be considered in welding of lead, usually called lead soldering and explains the practical performance by means of examples. EF

Silver Solders. (Silberlote.) K. Kreidl & L. Nowack. *Metallwirtschaft*, Oct. 7, 1929, pages 991–992; Oct. 25, 1929, pages 1035–1038.

The properties of hard solders containing silver are considered and the appearance of microstructure is discussed. A large number of illustrations are included. EF

Welding and Cutting

Welding Withstands Hurricane. *Electrical World*, Nov. 30, 1929, page 1070.

The completely arc-welded steel framework of a large fruit-packing house in Florida proved a match for a terrific hurricane which laid low all buildings of ordinary construction. No weld connections were broken and easy replacement and repair to the distorted members of the steel framework are advantages of the arcweld over riveted construction. WHB

Aircraft Welding, Including Development of an Efficient Welding Department. Russel F. Hardy. *Modern Machine Shop*, Dec. 1929, pages 24–30.

Paper before the 30th Annual Convention of the International Acetylene Association, Chicago, Ill., Nov. 13–15 1929. The chief engineer of the Waco Aircraft Co. discusses the importance of developing the welding department in airplane manufacture to its highest efficiency and gives the method of obtaining best results. The proper welding process is discussed. MLM

Basic Principles of the Carbon-Arc Welding Process are Explained. P. P. Pipes. *O-B Bulletin*, Nov.-Dec. 1929, pages 11–13.

Welding of rails is discussed from a metallurgical standpoint and from a mechanical standpoint. MLM

Application of Automatic Shape Cutting Machines to Welded Steel Products. Otto C. Voss. *Paper at the 30th Annual Meeting of the International Acetylene Association*, Chicago, Ill., Nov. 13–15, 1929.

The automatic oxy-acetylene machine is described and its uses in the Allis-Chalmers Mfg. Co. enumerated. MLM

Hammer Welding of Pure Aluminum and Its Plastic Alloys. (Das Hammerschweisen von Reinaluminium und seiner knetbaren Legierungen.) H. Reininger. *Metallbörse*, June 6, 1929, pages 1378–1380; June 29, 1929, pages 1433–1434.

By means of examples the author shows the possibility and applications of hammer-welding for Al and its alloys. The problems of composition of material, preliminary treatment of the objects and the result of welding are shown in micrographs. EF

Report of the Oxy-Acetylene Committee of the International Acetylene Association. 1929, 86 pages.

Presented at the annual meeting of the Society. The report gives a fairly precise view of the progress of the welding industry. The section devoted to welding materials gives the process for welding steel as well as non-ferrous alloys. There is a short chapter on oxy-acetylene processes in steel mills, and chapters on the process in the aircraft industry and in the chemical industry. Some mention is made of bronze and copper welding. There is a summary of data and researches sponsored by the Society of German Engineers (V. D. I.). The report is mainly excerpts from some of the papers presented at the meeting. MLM

How to Weld Duralumin. *Aero Digest*, Dec. 1929, page 164.

This article describes the properties of duralumin and gives in detail the process of welding it. The average tensile strength which can be expected in welds made in Duralumin is given. MLM

WORKING OF METALS AND ALLOYS

The Working of Aluminum. (Die Bearbeitung der Aluminiums.) H. Krause. *Apparatebau*, June 14, 1929, pages 133–135.

The author considers the behavior of Al in the following mechanical processes: annealing, rolling, drawing, extruding, filing, sawing, drilling, planing, boring and grinding. EF

Melting and Refining

A Method for Charging Electric Furnaces. (Procede de chargement de fours electriques.) *Journal du four electrique*, Sept. 1929, page 298.

The use of vertical baffles is proposed in order to improve the distribution of electric furnace charge. JBG

Vacuum Melting for Quality Steel—Why Not? H. W. Gillett. Metals & Alloys, Aug. 1929, Vol. 1, pages 72–73.

A correlated abstract covering some of the recent work on vacuum melting on metals and alloys other than steel.

The Effect of Melting Conditions on the Properties of Cast Iron. A. L. Norbury. *Research Report* No. 76, *British Cast Iron Research Association.*

This report continues the experiments previously outlined in which some remarkable differences between irons of the same chemical composition, due to differences in melting conditions were noted. The present report deals with the effect of super-heating, the effect of adding small additions of steel to the ladle, and differences in structure due to the use of different ferro-alloys. The effect of bubbling gases through the melt is also considered. In Part 2 of the report a number of earlier results from other sources are quoted to show that the results outlined in Research Report No. 67 from crucible melts are not widely different from those normally obtained in cupola practice if proper regard is paid to the inevitable differences in composition. In this respect the influence of manganese is very marked, as shown in Research Report No. 63. Part 3 of the present report deals with various proprietary methods of producing cast iron and attempts to relate the properties to the general ideas embodied in Research Reports Nos. 67, 68 and the present report.

The Effect of the So-called Utah Shale "Fluxes" on the Dispersion of Lead in Copper-Lead Alloys. G. L. Craig. Metals & Alloys, Oct. 1929, Vol. 1, pages 162–165.

The results obtained by the author show that no increased dispersion was obtained by the use of the shale flux. No beneficial effect of the shale was noted in any respect. The shales appear to have no "fluxing" action of any sort. The only effect noted was a detrimental one, namely, the tendency of the casting to contain included particles of scale.

Electric Furnaces for Steel Melting. N. Ryland Davis. *Foundry Trade Journal*, Dec. 19, 1929, pages 437–438.

A paper read before the Manchester Association of Engineers, Dec. 13, 1929. Discusses the inefficiency of the crucible process as compared with other methods of steel melting. A general comparison between electric furnaces and fuel fired furnaces cannot be made. Compares 4 classes of electric furnaces. Describes the induction furnace, in which it is possible to make better steel than in the crucible furnace. VSP

The Physical Chemistry of Steel Making. Alex. L. Feild. Metals & Alloys, Dec. 1929, Vol. 1, pages 279–281.
A correlated abstract discussing the reports read at the third open meeting of the Metallurgical Advisory Board to the Carnegie Institute of Technology and the United States Bureau of Mines. Meeting reported on pages 297–298.

A New Development in Wrought Iron Manufacture. James Aston. *Technical Publication* No. 228, *American Institute of Mining & Metallurgical Engineers*, 12 pages.
See Metals & Alloys, January 1930, page 344. EF

Diffusion of Iron Oxide from Slag to Metal in the Open-Hearth Process. C. H. Herty. *Technical Publication* No. 229, *American Institute of Mining & Metallurgical Engineers*, 18 pages.
See Metals & Alloys, January 1930, page 344. EF

Technical Problems during Solidification of Metals. (Technische Probleme bei der Erstarrung der Metalle). G. Masing. *Zeitschrift für Metallkunde*, Sept. 1929, pages 282–286.
The author summarizes the more important factors which exert an influence during solidification of metals, resulting in crystal fibers, pipes, porosity and contraction, direct and reversed segregation, and considers the significance of the intermediate substance. EF

Forging

Forging and Machining a Heavy Crankshaft. James R. Cornelius. *American Machinist*, Oct. 31, 1929, pages 745–746.
Describes the operation and machinery used in forging and machining large crankshafts for Diesel engines. RHP

Casting and Solidification

The Centrifugal Casting Process. (Gas Schleuderguss-Verfahren.) H. Simon. *Zeitschrift für Metallkunde*, Sept. 1929, pages 302–304.
The paper presented before the "Deutsche Gesellschaft für Metallkunde," May 1929, discusses, after reviewing the history, the centrifugal casting of iron and non-ferrous metals and their alloys, considers the large variety of simple and complicated castings and the required properties, and compares centrifugal casting with sand casting. EF

The Origin of the Cast Structure. (Die Entstehung der Gusstruktur.) G. Tammann. *Zeitschrift für Metallkunde*, Sept. 1929, pages 277–282.
The paper presented at the "Deutsche Gesellschaft für Metallkunde," May 1929, treats of the principal factors influencing the development of the texture of solidification as number of nuclei as centers of crystallization and linear velocity of crystallization in relation to under-cooling, formation of granular structure, fluctuations in grain size, fiber crystals, microscopical capillaries in castings, and the intermediate substance between crystal boundaries consisting of silicates, oxides, carbides, phosphides, sulphides, etc. EF

Centrifugal Casting of Metals. (Der Metallschleuderguss.) O. Junker. *Metallwirtschaft*, Oct. 18, 1929, pages 1018–1019.
Recent progress in centrifugal casting, i. e., the manufacture of annular sheets in water-cooled molds and the economy of this particular process is considered. EF

Machining

Superhard Metals for Tool Facing. H. J. Morgan. *Technical Publication* No. 256, *American Institute of Mining & Metallurgical Engineers*, 16 pages.
The author compares diamond with its substitutes and particularly discusses tungsten carbide cast and wrought inserts and "case hardening" by which he means a hard layer applied by electric welding. Material used is referred to as "Blackor" composition of which is not given. EF

Drawing and Stamping

Experience with Widia Metal Dies. Morris Simons. *Wire & Wire Products*, Jan. 1930, pages 26–28.
In spite of the higher initial cost, Widia metal dies are more economical than chilled iron or steel dies on a basis of die cost per unit of material drawn. The necessity for proper care of dies is discussed MLM

The Effect of Drawing on the Temperature Coefficient of the Electrical Resistivity of Constantan. R. S. J. Spelsbury. *Journal Scientific Instruments*, Nov. 1929, pages 357–358.
The temperature coefficient of electrical resistivity of commercial constantan wire is a very variable quantity. The coefficients of samples obtained by the author varied from a positive value of 60 parts in 1,000,000 per degree C. to a negative one of 80 parts in 1,000,000. The principal practical deduction is that where fine wire is required it is necessary to start with material of positive coefficient. This is unfortunate, as the bulk of the commercial material shows a negative value. MLM

Pickling

Pickling Iron Wire. Ing. Heinrici. *Wire and Wire Products.* Dec. 1929, pages 412–413.
Translated from Draht-Welt Export-Ausgabe, Halle, Germany. Old and new methods of pickling are considered, with especial attention paid to the Charpy process. The factors of dilution and acidity control are discussed. MLM

Investigations on Pickling of Steel Sheets with a Low Carbon Content. (Untersuchungen über das Beizen von kohlenstoffarmen Flussstahlblechen.) P. Bardenheuer & G. Thanheiser. *Stahl und Eisen*, Aug. 15, 1929, pages 1185–1192; *Mitteilungen aus dem Kaiser Wilhelm Institute für Eisenforschung*, 1928, Vol. 10, pages 323–342.
The different viewpoints in literature on pickling pits are given. Most recent investigations seem to prove that the origin of pickling pits results from hydrogen, which diffuses into the material with pickling. The following was investigated: relations between sheet thickness and hydrogen diffusion, hydrogen diffusion, pickling temperature and concentration of acid and the influence of treatment and quality of material and its tendency to pickling failures. Material: C 0.09%, Si 0.03%, Mn 0.39%, Cu 0.18%. The quantity of diffusing hydrogen is about proportional to sheet thickness. Diffusion in steels with higher carbon content depends very much on pearlite form. Sheets with globular cementite are more easily penetrated than those with lamellar pearlite. Developed hydrogen rises with temperature faster than diffusion. The amount of diffused hydrogen, therefore, decreases with temperature. In pickling with HCl less hydrogen diffuses than in pickling with H_2SO_4. A higher pickling temperature is favorable. Additional pickling means a lower volume of formed hydrogen. The volume of hydrogen increases with acid concentration. The volume of diffusing hydrogen increases in H_2SO_4 but decreases in HCl. Segregations favor the formation of pickling pits. Degasified steel has a lesser tendency to form pickling pits. GN

Inhibitors as a Means of Reducing Corrosion. E. L. Chappell. *Chemical & Metallurgical Engineering*, Sept. 1929, page 539.
Inhibitors, which were originally used in pickling tanks to prevent or diminish acid attack upon metals, are now being added to acid solutions for other commercial uses. Many of those recently introduced have been found to be very effective. Gives a summary of inhibitor action. MS

Inhibitors in the Action of Acid on Steel. F. H. Rhodes & Wayne E. Kuhn. *Industrial & Engineering Chemistry*, Nov. 1929, pages 1066–1070.
Measurements were made to determine the efficiencies of several organic compounds of nitrogen as inhibitors in the action of H_2SO_4 on iron. The most efficient inhibitors were cylic compounds which contained an atom of nitrogen in the ring. The addition of inhibitors of this type to dilute sulphuric acid in contact with iron increases the interfacial resistance between the acid and the iron. It seems that adsorption on the surface of the metal is a necessary condition for inhibiting action. Experiments actually show that such adsorption takes place. MEH

Cold Working

Hardness Distribution Produced by Cold Working. W. P. Sykes & A. C. Ellsworth. *American Machinist*, Sept. 26, 1929, page 547.
From a paper entitled "On the Distribution of Hardness Produced by Cold Working," presented at the meeting of the American Society for Steel Treating, Cleveland, Sept. 9–13, 1929. See Metals & Alloys, Jan. 1930, page 344. RHP

The Influence of Cold Working on the Magnetic Properties of a Carbon Steel. (Der Einfluss des Kaltreckens auf die magnetischen Eigenschaften eines Kohlenstoffstahles.) W. S. Messkin. *Archiv für Eisenhüttenwesen*, Dec. 1929, pages 417–425.
The author investigated the influence of cold working and annealing on the magnetic properties of a carbon steel with 0.78 C. The influence of the drawing temperature of quenched C and Mo steels on the magnetic properties was observed. In every case the decrease of the coercive force is retarded starting with a certain drawing temperature. This retardation develops into a secondary maximum after severe cold work and after quenching. A companion of hardness and coercive force showed no relation between the two. Quenching experiments with cold worked samples showed that the relation of the coercive force after quenching to the hardness of the original material (De Fries, *Transactions American Society for Steel Treating*, Aug. 1925, page 139) only exists for alloy steels with special carbides. Recent results (Mauer & Schröter, *Stahl und Eisen*, June 27, 1929, Vol. 49, page 929) on the phenomena in quenched steels during drawing were checked. CK

Effects of Cold Working on Physical Properties of Metals. R. L. Templin. *Technical Publication* No. 238, *Amercian Institute of Mining & Metallurgical Engineers*, 17 pages.
Includes discussion. The effects of working are lessened at temperatures above room temperature and increased at lower temperatures. Upon cold working annealed wrought metals there is usually a constant increase in strength up to a certain point where there is either a marked increase or a marked decrease in the hardening with additional work. As examples, aluminum when cold worked in excess of about 80% reduction of area hardens rapidly with increasing reduction and magnesium when worked in excess of about 45% reduction of area hardens at a decreasing rate. The actual tensile strength of cold worked metals is given by $T = T_o(1 + aR)$, where T is the tensile strength in pounds per square inch, T_o is the tensile strength of the properly annealed metal, a is a constant, and R is the reduction of area expressed as a decimal. The value of "a" varies from 0.9 for aluminum to 1.8 for brasses and bronzes. The changes in yield point, elongation and hardness due to cold work are also discussed. Curves are given showing the changes in the physical properties of aluminum with cold working. JLG

Cleaning

Removing Fat from Metals. (Entfetten von Metallen.) H. Münter. *Metall*, Aug. 25, 1929, page 137.
The removal of oil and fat from Zn is performed by an alkaline dip bath which contains saw dust. The alkaline concentration should not be too high. A small addition of ammonia is recommended. Drums are used for articles in bulk. Such an installation and its operation is described. In case of Al, stronger alkaline solutions for cleaning must be employed. EF

Stripping Chromium Plate. R. W. Mitchell. *Metal Industry*, New York, Jan. 1930, page 22.
Recommends electrolytic stripping in an alkaline solution. Stripping with hydrochloric acid pickle is fast, but it is costly and inefficient. Gives results of test conducted; Magnus platers, cleaner being used as an electrolyte. VSP

Grinding

Grinding of Cemented Tungsten Carbide. H. W. Wagner. *Grits & Grinds*, Nov. 1929, 16 pages.
This booklet gives the problems that may arise in the grinding of tungsten carbide and the method of surmounting them. The process of grinding is given in detail and a table appended showing the grinding wheels recommended. MLM

DEFECTS

Hair Line Cracks on the Surface of Plates. Erich A. Mateyka Metals & Alloys, Aug. 1929, Vol. 1, pages 80–81.
Translation of an article from *Stahl und Eisen*, May 2, 1929, pages 643–645. See Metals & Alloys, Aug. 1929, page 78.

Progress on the Problem of Transverse Fissures in Rails. M. E. McDonnell. Metals & Alloys, Sept. 1929, Vol. 1, pages 93–97.
The problem of transverse fissures is briefly considered, as well as the suggestions for prevention and detection of fissures. Comment on this article appeared in Metals & Alloys, Jan. 1930, pages, 312–313.

Photomicrograph Explains Surface Cracks. John Marchmont. *Modern Machine Shop*, Jan. 1930, page 56.
Investigation shows that surface cracks may be caused not only by incorrect heat treating but also by using the wrong grade wheel and wrong feed in grinding. MLM

CHEMICAL ANALYSIS

A Potentiometric Method for the Determination of Iron and Molybdenum. (Eine Potentiometrische Methode zur Bestimmung von Eisen und Molydan.) H. Brintzinger & W. Schieferdecker. *Zeitschrift für Analytische Chemie*, April 10, 1929, pages 110–112.
Describes a method which permits the quantitative determination, hitherto very difficult, in a single titration process by means of a solution of $CrCl_2$.

The Magnetic Determination of Carbon in Steel with the Malmberg Carbometer. (Die magnetische Schnellbestimmung des Kohlenstoffs im Stahl mit dem Karbometer von Malmberg.) Paul Klinger & Herbert Fucke. *Archiv für Eisenhüttenwesen*, Nov. 1929, pages 347–352.

The authors test the magnetic determination of carbon with the Malmberg Carbometer. Based on test melts calibration curves for pure carbon steels and the influence of the individual alloying constituents on this is determined by corrections. The instrument was found very satisfactory in the melting operation, especially if the same steels are manufactured all the time.

A Complex Chemical Method for the Determination of Silver. (Eine Komplex chemische Methode zur Bestimmung von Silber.) F. Feigl & J. Tamchyna. *Berichte Deutschen Chemischen Gesellschaft*, Sept. 18, 1929, pages 1897–1901.

Determination as AgCN is established and advantages discussed. EF

A Method for the Separation of Lead and Bismuth. (Ueber ein Verfahren für die trennung von Blei und Wismut.) H. Blumenthal. *Zeitschrift für Analytische Chemie*, April 10, 1929, pages 206–213.

If a weak nitric acid solution of lead and bismuth is boiled with an excess of freshly precipitated slime of mercury-oxide the total contents of bismuth is precipitated as basic nitrate if the conditions described in the paper are adhered to. In this way it is possible to separate the lead from the bismuth by a single precipitation and to obtain even the smallest amounts of bismuth in an easily filterable form. Ha

PLANTS AND LABORATORIES

Current Metallurgical Research at the Bureau of Standards. H. S. Rawdon. Metals & Alloys, Oct. 1929, Vol. 1, pages 144–152.

The author reports on the activities of the Metallurgical Division of the Bureau of Standards. Work relating to metals carried on outside the Metallurgical Division is also considered.

MISCELLANEOUS

A New Conception of the Mechanism of Metallic Conduction. H. M. Barlow. *London, Edinburgh & Dublin Philosophical Magazine*, Sept. 1929, pages 289–304.

The author regards the assembly of conduction electrons as forming what is equivalent to an incompressible fluid rather than a gas. The nature of conduction is considered. EF

Reliability of Fusible Tin Boiler Plugs in Service. John R. Freeman, Jr., J. A. Scherr & S. J. Rosenberg. *Bureau of Standards, Journal of Research*, Jan. 1930, Vol. 4, pages 1–22.

In cooperation with the Steamboat Inspection Service a study has been made of the reliability of fusible boiler plugs of the type installed in ships' boilers under the jurisdiction of the Inspection Service. It has been found that under certain conditions fusible plugs would not operate due to the formation in service of a refractory oxide replacing the tin in the fire end of the plug. Apparatus is described in which plugs may be tested under simulated service conditions. The results of examination and tests of 184 plugs returned from service indicated that 10 percent of all plugs in service would not operate when and if required. Recommendations regarding specifications and design of plugs to eliminate this dangerous condition are made.

Twelfth Annual Meeting of Gesellschaft für Metallkunde. Metals & Alloys, Nov. 1929, Vol. 1, pages 231–232.

Brief report of the meeting on September 7–9, 1929, in Düsseldorf, Germany.

National Metal Congress. Metals & Alloys, Oct. 1929, Vol. 1, pages 166–168.

The technical sessions of the four cooperating societies are briefly discussed.

Reclaiming Non-Ferrous Scrap Metals at Manufacturing Plants. Francis N. Flynn. *Technical Publication* No. 233, *American Institute of Mining & Metallurgical Engineers*, 7 pages; *Brass World*, Nov. 1929, pages 267–268.

From a paper read at the Fall Meeting of Institute of Metals Division, Sept. 9–12, 1929. A brief review of the types of scrap and methods of treatment employed in the automobile industry. Tables show: a classification, reclamation and final disposition of scrap, charges in the cupola smelting of scrap and the metals produced in brick-lined cupolas. Advantages of the brick-lined over the water-jacketed cupola are: (1) time saving in preliminary furnace warming, (2) greater familiarity of brass-foundry workmen with pig-iron melting furnace operation than with a water-jacketed cupola, (3) slag production free from iron and high in alumina, (4) the metal can be made lower in iron and (5) a furnace campaign lasts one shift instead of a week or more. The single disadvantage is the patching of the firebrick lining after each run. WHB

Annual Autumn Meeting of The Institute of Metals, Düsseldorf, Sept. 9–12, 1929. Metals & Alloys, Dec. 1929, Vol. 1, pages 299–300.

Brief report of the meeting.

Progress in Standardizing Ingot Metals. *Metal Industry*, New York, Jan. 1930, page 28.

Discusses progress made in the formulation of a code of specifications for copper alloys in ingot form. The committee is a special one of the American Society for Testing Materials. According to the committee report at present there are 599 separate specifications on copper alloy ingots. These can be reduced to 30 or 40. Approximately 40 alloys are known as 85–5–5–5 mixture. Their range is:

	% Minimum	% Maximum
Copper	83	86
Lead	4	6
Tin	4	6
Zinc	4	6
Antimony		0.25
Iron		0.35
Nickel		0.75
Sulphur		0.06
Phosphorus		0.06
Total impurities		0.77

VSP

Application of the Press Finish Process in the Shop. (Die Anwendung des Aufdornens von Bohrungen in der Werkstattpraxis.) O. Schlippe. *Metallwirtschaft*, Sept. 20, 1929, pages 915–916.

The paper contains: progress of the press finish process in the shop, the difficulties still encountered and recent publications mostly of American origin. EF

Recovery of Fine-gold, Fine-silver and Platinum from Scrap Metal and Filings. (Gewinnung von Feingold, Feinsilber und Platin aus Altmetall und Feilung.) E. Rosenbaum. *Deutsche Goldschmiede Zeitung*, May 11, 1929, pages 3–5.

The separation of scrap gold and scrap silver and the separation of filings containing Pt, Au, Ag and Cu is described. EF

The Manufacture of Alumina Abrasives in Electric Furnaces. (La fabrication d'abrasifs alumineux au four electrique.) A. Decary. *Journal du four electrique*, Sept. 1929, pages 299–302.

An outline of the manufacturing data of alumina base abrasives. JBG

Results and Benefits of Simplifying the Classification of Iron and Steel Scrap. H. P. Dalzell. *Commercial Standards Monthly*, Nov. 1929, pages 132–134.

The article discusses the specifications for classes of scrap, and the benefits derived from a uniform classification. MLM

Oxidation and Polishing of Silver-plated Articles. (Das Oxidieren und Polieren versilberter Waren.) W. Sack. *Metall*, July 7, 1929, pages 107–108.

The author details the various methods of the rare-metal industry in regard to surface finish of silver plated products. EF

The Eleventh Annual National Metal Exposition. Metals & Alloys, Oct. 1929, Vol. 1, pages 169–170.

The exhibits of interest to those interested in metals and alloys are briefly described.

Fifty-Sixth Meeting of the American Electrochemical Society. Metals & Alloys, Oct. 1929, Vol. 1, page 171.

The titles of the papers of metallurgical interest read before the annual meeting in Pittsburgh are given.

Thermo-Chemistry of Iron, Manganese and Nickel. (Beiträge zur Thermochemie des Eisens, Mangans und Nickel.) W. A. Roth. *Archiv für Eisenhüttenwesen*, Nov. 1929, pages 339–346.

The authors determined the heat of formation of different compounds of these elements by direct combustion methods. The heat of formation decreases from Mn towards the Ni over the iron. The heat of formation of the metal oxide for the 3 elements is respectively + 96.2, + 64.0 and + 58.6; for the carbides + 23, −5.4 and −9.2. The authors furthermore investigated the heat of formation of Mn_3O_4, Fe_3O_4, Fe_2O_3, $MnCo_3$, $FeCo_3$ and $FeCo_5$. The results are partly in agreement with the previous literature, in part correcting very erroneous data. CK

FOUNDRY PRACTICE AND APPLIANCES

Reclaiming Steel-foundry Sands. A. H. Dierker. *Technical Publication* No. 261, *American Institute of Mining & Metallurgical Engineers*, 15 pages.

Data on the chemical and physical properties of used steel-foundry sand are given and the method developed for reclaiming this sand is described. In a typical weeks operation using a muller-type sand mill and an air classifier followed by a dust collector the recovery was 85.4%. JLG

Hidden Facts in Oil-Sand Core Practice. F. Hudson. *Foundry Trade Journal*, Dec. 19, 1929, Vol. I, pages 443–446; II, Dec. 26, 1929, pages 459–460, 464.

Paper read before the New Castle branch of the Institute of British Foundrymen. Object is to promote interest in research relative to the fundamental principles required for successful, economical and efficient oil-sand core practice. The points discussed in this installment are: effect of sand relative to binder economy and core—(a) strength, (b) permeability, (c) finish, (d) heat conductivity, (e) refractoriness and (f) gas evolution on casting. Includes also a general description of the laboratory and methods used. Discusses the effect of binders relative to core—(a) strength, (b) permeability, (c) finish and (d) gas evolution on casting. Contains several tables giving results of tests conducted. Includes discussion. VSP

Fins Cause Unmachinable Castings. G. M. Eaton. *Iron Age*, Nov. 28, 1929, pages 1446–1448.

White iron edges on machined surfaces of cylinder heads and blocks for internal combustion engines are often responsible for failures. An investigation has recently been made into the causes of white iron edges. Irons investigated included: unalloyed irons, chrome-nickel irons and chrome-molybdenum irons. In over 90% of castings edged with white iron the hard edge was due to presence of fin on rough casting which acted as a chill. Methods used to prevent formation of fins on edges are: first, move parting line so fin lands on rough casting as far from machined surface as possible; second, grind cores to a fit so close that fin is of immaterial thickness. Considers also the responsibilities of designers and the foundries. VSP

The Founding of Some High Melting-point Non-ferrous Alloys. J. McNeil. *Foundry Trade Journal*, Nov. 28, 1929, pages 385–388.

Paper read before the London section of the Institute of British Foundrymen. Deals with the importance in selecting the proper alloys to meet rigid specifications. Of the various non-ferrous alloys available, those containing large percentage of nickel are the most suitable. Discusses alloys within the following series: nickel silvers (alloys of nickel, copper and zinc), nickel copper alloys and nickel chromium alloys. Takes up furnaces used for melting, proper furnace lining and melting temperatures. Considers effect of casting temperatures on properties of alloys. VSP

Cast Aluminum Alloy that Compares with Die Castings. Lewis H. Fawcett. *Iron Age*, Dec. 26, 1929, pages 1722–1724.

Discusses method employed by the United States Naval Gun Factory. The composition of the alloy used is 95% aluminum and 5% silicon, designated as Navy Department specification 46Ala, class 2. Metal and hard wood patterns are used. Molding is done in green sand using No. 0 Albany sand which is mixed, $^1/_5$ new and $^4/_5$ used sand for the facing material. Accurate temperature control is employed not only to improve the physical properties but to minimize shrinkage. Machining is done simply by milling the end ribs. VSP

FURNACES & FUELS

Progress in Electric Furnaces for Non-ferrous Metals. M. Tama. *Metal Industry*, London, Oct. 11, 1929, pages 341–345.

Paper read at the Düsseldorf meeting of the Institute of Metals. See Metals & Alloys, Jan. 1930, page 345. VSP

Metal Melting by Electricity. D. F. Campbell & W. S. Gifford. *Foundry Trade Journal*, Dec. 26, 1929, pages 453–455.

Paper read before the joint meeting of the London section of the Institute of British Foundrymen and the Institute of Metals. Deals with the different types of electric furnaces, such as the arc, induction, high frequency furnaces, etc., which have been developed for metal melting. Gives detailed account only of those types which have proved the most successful. Includes analysis and relative cost of production by various furnaces. VSP

Fuels for Heat Treating. Robert M. Keeney. *Iron Age*, Jan. 2, 1930, pages 58–59.

Electric heat in industry continues to expand and as in case of manufactured gas, a large part of growth is in the heat treating operations. Oil is replacing coal in heat treating. Two important developments stand out as the result of intensive metallurgical research: (1) short cycle anneal of malleable castings in electric furnace, and (2) finishing anneal of brass sheets in gas furnace. Research work on atmospheric control of electric and gas furnaces during heat treating may be productive of results in 1930. VSP

Translation

Negotiations are under way which will assure the appearance of translations of articles appearing in foreign publications. Under this arrangement, the readers of METALS & ALLOYS *will be assured of receiving in English the best articles shortly after they appear abroad.*

The Electrodeposition of Chromium on Metals

By W. Birett, Berlin-Siemensstadt, Germany

(*Translated by special arrangement from Zeitschrift für Metallkunde, Nov. 1929, Vol. 21, pages 372–377.*)

A few years ago, when the trade journals published the first articles on chromium plating, and when chromium plated parts first came into public use on busses, trolley cars, etc., the opinions concerning this new branch of electrodeposition were very divergent. Those who habitually receive innovations with skepticism considered chromium plating of doubtful utility and, basing their opinions on Ostwald's theory, were even prepared to prove scientifically the unsuitability of this new covering medium in view of the base properties of active chromium. Others, on the contrary, predicted the complete abolition of nickel plating and, basing their opinions on the noble properties of passive chromium particularly on its resistance to corrosion, declared that the corrosion of metals, in particular, that of iron, had been practically overcome.

Curiously enough, the developments of the past years have confirmed neither of these theories. It is true that in the active state chromium is readily attacked, and all factors which promote its activity, such as for instance the chlorine ions of hydrochloric acid, should be carefully avoided in order not to defeat the purpose of the protective properties of the chromium covering; fortunately, under ordinary conditions the atmospheric oxygen insures a passivity sufficient to protect the metal coat against corrosion.

The advantages of chromium plating are due chiefly to 3 properties of this metal, namely, its hardness, its corrosion resistance to oxidizing agents and its heat resistance.

Chromium is one of the hardest metals. It is harder than glass and its inherent hardness is further increased by the hydrogen absorbed during the deposition.

The corrosion resistance of chromium depends upon the passivity. In the passive state the potential of chromium is shifted considerably toward the "noble" region. It is for this reason that passive chromium exhibits a high resistance to acids and other chemical agents, provided there is no activity. The passivity is caused and maintained by oxidizing effects upon the metal. For this reason, oxidizing agents such as nitric acid, chromic acid, permanganate and particularly atmospheric oxygen, which are the chief causes of the rapid corrosion of iron, nickel, brass, copper and other ordinary metals, exert a protective influence upon chromium.

The heat resistance of chromium is due to its high melting point which is about 1560° C.

From the above it will be seen that chromium plating improves the metal upon which it is deposited from the standpoints of hardness and resistance to corrosion and heat. The fact that chromium plating, in spite of its evident advantages, has come into general use very slowly and only recently is due to the fact that its development had to overcome special and considerable difficulties. Now that chromium plating is past its experimental stage and has outgrown its infancy, it offers a good protective coating against a variety of attacking agents and has become a valuable and indispensable industrial process.

Practice of Chromium Plating

Chromium plating is one of the electrolytic processes in which one or more metals which are contained in aqueous solution in the form of their salts are directly deposited, by means of the electric current, upon the part or article to be covered.

One of the operating conditions which are applicable to all electrolytic processes is that, in order to produce a dense nonporous deposit, there must be available a sufficient number of metal ions. Therefore, it will be possible to operate with considerably higher current densities with so-called acid baths, such as copper sulphate baths, than will be possible with alkaline baths, such as cyanide baths, whose content of free metal ions is considerably lower and whose equilibrium, which has been disturbed by the deposition of ions, must first be re-established.

The electrolyte exclusively used in chromium plating is an aqueous solution of chromic acid which contains the chromium as an ion. Various concentrations are used according to the intended purpose of the deposits. An average figure in practice is 250 to 500 grams of chromic acid. Usually the plating baths contain sulphuric acid in various amounts, as well as various addition agents.

Chromium has a "baser" potential than hydrogen. It is therefore necessary to work with a voltage exceeding that of hydrogen and approximating that of chromium. The high current density required and the simultaneous separation of hydrogen usually cause a certain porosity of the chromium deposits.

The transformation of hexa-valent chromium ions into trivalent ions does not require a high potential; even the separation of the hexa-valent chromium ions from the acid radical takes place at a sufficiently rapid rate. However, the further transformation or neutralization to bi-valency (practically excluded) necessitates, relatively speaking, considerable power. With a sufficient amount of sulphate ions in the bath, the hydrogen ion concentration, i. e., the acidity of the solution, is sufficiently high to counteract the formation of insoluble oxides upon the cathode from the very start.

The preparation for chromium plating, that is, the removal of greases, dirt and oxides, is the same as for other types of electroplating. It is true that the chromic acid attacks the greases; yet it is urged that this should in no way be considered a substitute for the usual cleaning operation.

As has been stated above, the current density and voltage required are relatively high, considerably higher than in nickel plating or copper plating; however, the durations of the treatment are usually considerably shorter.

The yield, that is, the amount of metal deposited per ampere hour in comparison with the amount to be expected theoretically, is not very high. The chief effect of the current is represented by the generation of hydrogen; this effect is the greater, the lower the current density. The average yield in metallic chromium is about 20 percent; it fluctuates with the temperature and with the configuration of the parts plated. The more complicated the configuration and the higher the temperature, the greater is the hydrogen separation and the lower the chromium separation.

Lead anodes are usually employed in chromium plating. The use of soluble chromium anodes is prohibitive owing to the high chromium prices and the poor working qualities of metallic chromium, and is furthermore impracticable for the following reason. At the cathode only $^1/_5$ of the effective current is used for the separation of the metal. Since, however, with chromium anodes it is necessary to take into consideration an anode dissolution of 100%, the chromium content of the solution would increase continuously and would render impossible the constancy of concentration and composition of the bath, a fundamental requirement in electroplating.

The throwing power of chromium plating solutions, i. e., their capacity for depositing metal particles also on those portions of the surface which are further removed from the anode, is poor, the same as with all processes working with a high voltage. Generally speaking it is poorer than that of a nickel bath, although there are cases where the converse was found to be true. An important point to be observed in this connection is that all oxides should be carefully removed from the surface to be chromium plated, as the reduction of these oxides in the strongly oxidizing chromic acid solution necessitates a high voltage; in the recesses of irregularly shaped articles the potential drop between cathode and solution is generally too small, and the reduction of the oxides, as well as the deposition of metal upon these reducing metal particles which have a large surface owing to their subdivision, is rendered impossible. In many cases the throwing power of the chromium plating bath can be considerably increased by rearranging the articles to be plated. It is to be observed that hydrogen generated at the cathode should be free to escape (see Fig. 1b) and should not be allowed to collect as in Fig. 1a, since in the latter case a deposition of metal upon the surfaces no longer in contact with the electrolyte is impossible. In view of the formation of a considerable quantity of hydrogen in chromium plating (we have seen that 80 percent of the current is consumed in this process), this precaution is of considerably greater importance here than in nickel plating where the formation of hydrogen is comparatively very small.

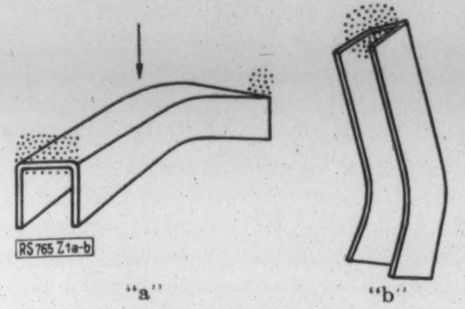


Fig. 1—Incorrect and Correct Position of the Piece in Chromium Plating. The Hydrogen Developed Must Be Free to Escape

The influence of the configuration of the articles upon the metal distribution may be seen from Figs. 2 and 3 which show various angles covered on the inside and on the outside, respectively. The facts shown apply to the chromium plating of copper, nickel, brass, bronze and of iron and steel containing less than 0.1% carbon. The obtuse angles show a perfectly uniform metal coat. With right angles there is already a noticeable decrease in the thickness of the coat at the corner and with acute angles the interior is not covered. The right-hand illustration shows the effect of rounding off the sharp angle; although the part comprises a right angle as does the second from the left, the coat has a uniform thickness. It is thus seen that it is possible to control the coat thickness and uniformity of the metal coat when designing the parts to be plated.

Fig. 3 shows the effect of an outer covering. Instead of a decrease at the corner there is an excess of metal. The rounding off of the corner cures this defect.

In chromium plating the thickness of the plate is exceedingly small, only a few thousandths of a millimeter. All the contours and lines of the base are clearly visible after the plating, in a manner similar to what obtains in nickel plating, for instance. However, while in nickel plating the metal coat is soft and ductile enough to permit its flattening out and polishing, the chromium coat is hard and projections cannot be flattened out, but must be ground off; see Fig. 4b nickel plated, 4a chromium plated. It is therefore always necessary to give to the articles to be chromium plated the surface condition desired in the finished product.

The chromium plate is either dull or bright, depending upon the temperature of the plating bath, see Figs. 5 and 6. The dull deposits produced in a cold bath, if they have been deposited upon well polished surfaces may be brightened up by suitable means such as dull nickel deposits. It is preferable, however, in most cases, to endeavor from the very beginning to cause the articles to emerge from the bath in a highly polished condition.

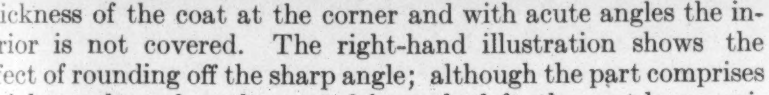


Fig. 2—Influence of Angle Size on the Internal Chromium Plates of Copper, Brass and Nickel

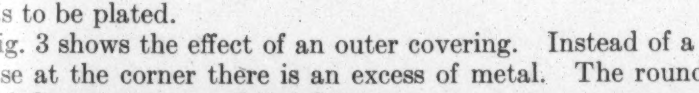


Fig. 3—Influence of Angle Size on the External Chromium Plating of Copper, Brass and Nickel

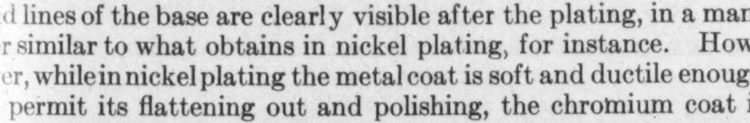


Fig. 4—Polishing of Nickel and Chromium Plate

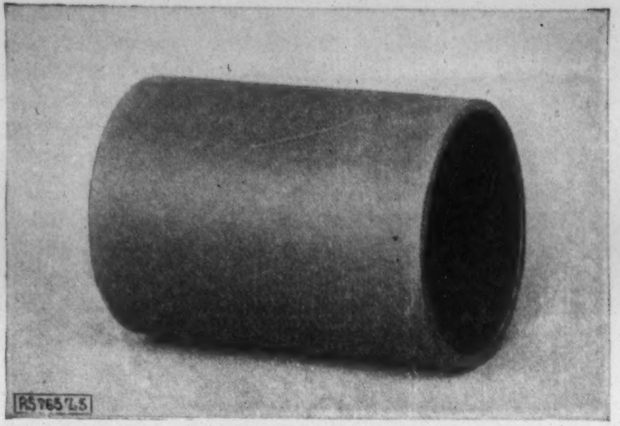


Fig. 5—Dull Chromium Plated Iron Pipe

Almost all metals and alloys of practical industrial application may be chromium plated. In judging the propriety of chromium plating in each individual case it is usually necessary to consider the object of the chromium plating, that is, whether it is desired to obtain a hard surface or resistance to corrosion.

With noble metals chromium plating will probably find little use, since the production of a hard surface for such parts is usually not desirable and since noble metals are resistant to corrosion to a very great extent.

When silver and lead are submerged in the chromium bath, there is produced immediately a thin film of silver or lead chromate which reduces considerably the adhesion of the chromium deposit upon the base metal. For this reason chromium plating of these metals is not advisable if the parts are to be subjected to mechanical stresses and strains.

A further fact to be considered in connection with chromium plating of lead is that this element may cause considerable trouble even if it is only an ingredient present in alloys, and this is the case not merely in pure chromium plating but also in other electroplating processes, such as in nickel plating for instance, which very often precedes chromium plating.

Base metals may be directly chromium plated if various technical details are strictly adhered to; the best that can be done in this direction, however, is a dull finish. Generally, it will be necessary or at least advisable to deposit first a more permanent intermediary coat of some other metal upon such base metals which are usually readily attacked by the chromic acid solution. The possibility of coating aluminum and aluminum alloys effectively with such an intermediary coat determines whether or not the deposition of a chromium plate thereupon is feasible.

The metals practically suitable for chromium plating are iron and steel, nickel, copper and their alloys. Chromium plating on other metals is not to be recommended. The fact that considerable differences may exist between various grades of iron, brass and bronze is generally known in electroplating and need not be emphasized here.

Whether or not it is advisable to deposit the chromium coat directly, depends upon the specific nature of the mechanical strains expected in the part when in use.

Application Based upon Hardness of Chromium

The nature of the practical use of chromium plated parts makes for the difference between success and failure of the so-called chromium "hardening."

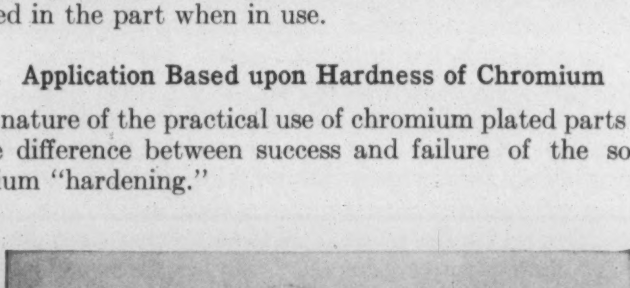


Fig. 6—Very Brightly Chromium Plated Lamp Fixture

In Fig. 7 is shown a soft base, wood for example, upon which has been applied a film of a hard material, say, sheet steel of 0.1mi llimeter thickness. It will be readily possible to drive an ordinary iron or brass nail through the thin iron coat, since the iron coat has not been subjected to hardness stresses, but only to tensile stresses. Only then will it be impossible to drive the nail through the iron coat if the base is hard enough to resist. It is a different thing if a piece of metal, say iron or brass, is caused to slide over the surface of the sheet steel. Under the resulting frictional stresses the wooden base is not in the least affected and the hardness of the thin steel coat is brought into play. The same considerations apply in chromium plating. In view of the extreme thinness of the chromium coat there can be no increased resistance against impact. It is only when frictional stresses are brought to bear on the chromium coat that there is an improvement; however, even in this case it should be borne in mind that the material forming the base of the chromium layer must be resistant enough to avoid its deformation which would result in too great tensile stresses on the chromium film. Another important point is to give the chromium layer a dull appearance. It has been found that owing to the high absorbed hydrogen content the chromium deposited in cold baths is harder than that deposited in hot baths.

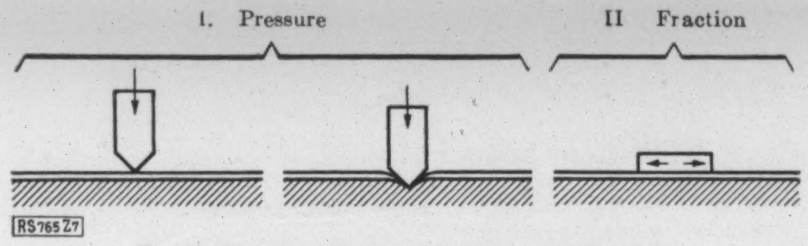


Fig. 7—Hardness Stress of Pressure and Friction

To mention a few examples of application we may refer to the chromium plating of iron and steel parts which are to be subjected to rolling friction, such as gears. An example of chromium plating of brass articles is to be found in the plating of gears for use in watches.

Other interesting applications relate to iron and steel printing plates, hard lead, in which the unfavorable properties of lead may be neutralized by the addition of tin and antimony; copper and small motor shafts running in bearings.

In the applications mentioned it does not appear advisable to provide the materials with an intermediate coating, since the coating metals suitable in these cases are considerably softer than chromium; furthermore, most electrodeposited metals have insufficient adhesion to the base to prevent separation therefrom under adverse conditions. The adhesive power of chromium is greater than that of other metals and suffices in these instances.

There is still another factor to be considered in chromium plating iron parts which are to be subjected to considerable stresses, and that is the so-called pickling fragility. As has been mentioned above, a portion of the hydrogen of the chromium plating solution is absorbed by the chromium deposit. With iron and cast steel this hydrogen diffuses into the base metal and thus produces the so-called pickling fragility so that the ultimate strength of the metal treated is considerably reduced. For this reason chromium plating is to be avoided, particularly if one of its objects is to produce a hardening effect, in all those cases in which an especially high breaking strength is called for, as for instance with axles or other load carrying parts of railroad cars, etc. In cases where the working stresses are less, as with axles or shafts of small motors, this factor may be overlooked; this also applies to such parts as pressed glass dies which are to be heated to considerable temperatures, since in this case, in addition to the formation of an alloy between coat and base metal, the elimination of the harmful hydrogen is hastened by this alloy and thus the fragility is obviated.

Applications Based upon the Heat Resistance of Chromium

These applications are based upon the high melting point of chromium which is in the neighborhood of 1560° C., as well as upon the high resistance of chromium to oxidizing and other chemical agents at high temperatures to such an extent that discolorations occur only at about 600—800° C.

In this connection we may mention chromium plated headlights, the light source of which causes considerable heating of the reflecting surface. Tests of about four to six weeks duration have shown that heating of the reflecting surface to temperatures around 400° C. failed to discolor the surface in the least, while nickel plated reflecting surfaces lost their luster after a very short time due to the formation of a film of oxide.

It is possible to affect soldering operations without any further operations on mirrors or reflecting surfaces made of sheet brass of 0.5 mm. thickness which are chromium plated on one side only. This material may be heated to about 500—600° C. at the soldering point without thereby causing dullness or oxidation.

Another field of application in this connection is that of the flat iron in which the oxidation of the bright heated surface is to be avoided even under the severe conditions of the corroding effect of the hot steam escaping from damp materials.

In contra-distinction to the applications mentioned so far in which the increase in temperatures merely causes an accentuation of the corrosion normally present, in chromium plating heating elements and dies, the facts are somewhat different. At the high temperatures which come into play here we encounter a more intensive attack upon the materials and for this reason the limit of the power of adhesion of deposits of nickel and of other metals is usually exceeded. For this reason it is customary to chromium plate such parts directly. Intermediate layers of nickel have caused unfavorable results since at the high temperatures involved these layers form blisters and separate from the base metal. Iron which has been directly chromium plated suffers only at the highest temperatures and at comparatively thick coverings from this defect of blistering, whereas with average thicknesses at such temperatures there sets in the formation of a solid solution capable of resisting even higher temperatures.

Conditions such as those mentioned are encountered in the pressed glass industry, for instance. In addition to temperatures of around 800—900° C., the effects of the attack caused by alkaline fluxes must be withstood here.

The dies used in this industry are produced by the manual cutting of the contours and details into the cast block. In order to enable and facilitate this manual work use must be made of a very soft cast metal composition into which enters a large amount of carbon and silicon and consequently a high graphite content.

Carbon which exerts a detrimental influence in all types of electroplating is the cause of particular difficulties in chromium plating. This is due to the fact that carbon acts as a depolarizer for the reduction of chromic acid, so that deposition of chromium upon graphite is possible only at very high current densities. In an experiment a deposit of chromium upon a graphite cathode was possible only after the current density was increased to 20,000 amp./sq. m. The voltage was considerably below the values which would have been required for equal current densities in the case of copper, nickel, etc. It is thus seen that the carbon particles have the troublesome property of decreasing the current density of the surface surrounding them.

The effect of all this upon the chromium plating of iron is shown in more detail in Fig. 8. Assuming similar conditions, it is shown schematically that in chromium plating the interior recesses of an article, the throwing power of the solution is influenced by the carbon content and silicon content of the iron. With good steel (left) the deposition is weaker in the inner portions of the angle iron than at the remaining surface. With iron of about 1% carbon (center) the inner portions are left uncovered. With an iron corresponding to that used in glass dies (right) the border of the chromium plate recedes still further from the apex.

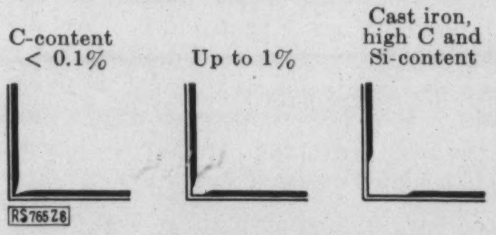


Fig. 8—Depth Effect When Chromium Plating Different Kinds of Iron

It is possible, however, by the use of suitable processes which may deviate considerably from the normal procedure, such as the application of current densities up to 6000 amp./sq. m. for instance, to effect a uniform deposit at the apex of this type of article.

As to the importance and value of chromium plating, it may be best to cite a concrete illustration: ordinary pressed glass dies such as shown in Fig. 9 have a useful life of about 5000 pieces. For this period of time the cleaning operation must be estimated to consume about 3800 hours, about 300 hours of which are consumed by the repairing and remodeling work which is done by a highly paid expert. Chromium plated dies which last 3 times as long may be estimated to consume about 150 hours for cleaning, in other words in this case about 500 working hours corresponding

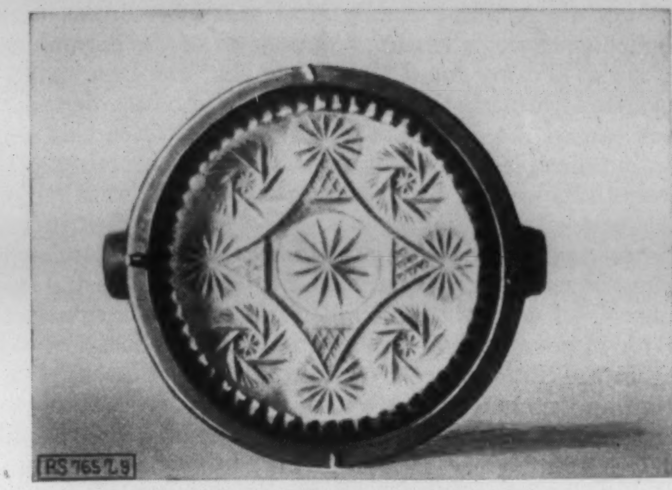


Fig. 9—Pressed Glass Die

to 15,000 pieces. Thus ordinary dies require 25 times as many hours as chromium plated dies.

A further field of application is the chromium plating of dies for lead casting such as are used, for instance, for casting storage battery plates. The die comprises a row of lamellae such as shown in Fig. 10, made of brass; they are held together by a frame. Liquid lead readily attacks brass. Experience has shown that chromium plating causes the liquid lead to run off the chromium coat the same as water runs off a greasy article, without in the least attacking it. Chromium plated lamellae have been found to be of an entirely permanent duration, provided the chromium deposit has been able to penetrate between the lamellae, and the base metal is not exposed at any point; this result may be readily attained in chromium plating.

In this connection it may be mentioned that nickel plating is unsatisfactory for this purpose since the recesses between the lamellae are not covered by the nickel plate.

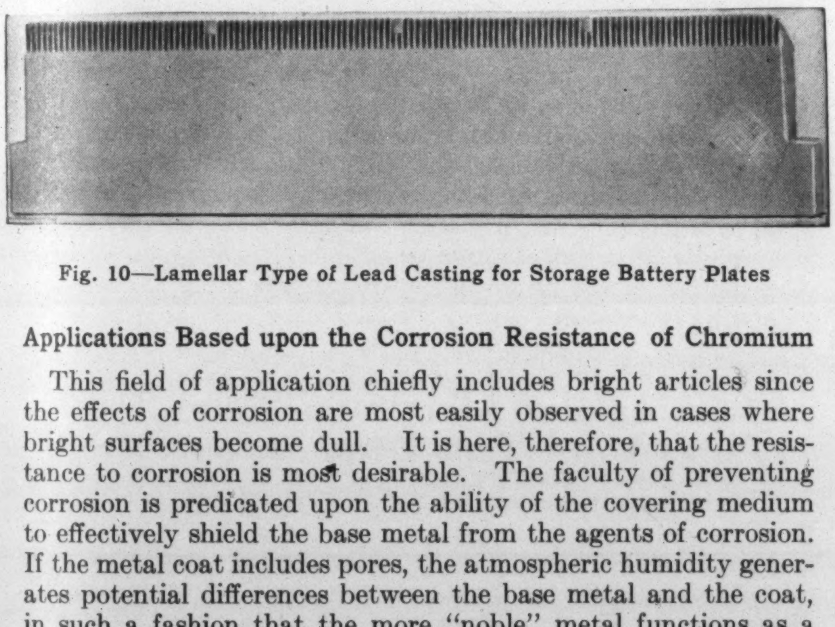


Fig. 10—Lamellar Type of Lead Casting for Storage Battery Plates

Applications Based upon the Corrosion Resistance of Chromium

This field of application chiefly includes bright articles since the effects of corrosion are most easily observed in cases where bright surfaces become dull. It is here, therefore, that the resistance to corrosion is most desirable. The faculty of preventing corrosion is predicated upon the ability of the covering medium to effectively shield the base metal from the agents of corrosion. If the metal coat includes pores, the atmospheric humidity generates potential differences between the base metal and the coat, in such a fashion that the more "noble" metal functions as a cathode and the more "base" metal goes into solution. This occurs whenever the pores of the coat are not closed by the products of the reaction. None of the electrolytic covering media is entirely free from porosity; there is a mere difference of degree between the various metals.

As we have seen, above the chromium plate is always porous. It is true that the deposit may be applied with a greater thickness so that none of the pores extend through the whole plate to the base metal, thus accomplishing a perfect and impermeable coat; however, economically speaking this is very undesirable, and on the other hand, the deposit includes internal stresses and strains due to the absorbed hydrogen, so that with thicker deposits, cracks and fissures are caused which expose the base metal. Generally speaking it is not possible to cover any article directly with a chromium plate in a manner to effectively counteract corrosion.

For these reasons it is advisable in the treatment of such metals which corrode by forming intensely colored or voluminous oxides such as, for instance iron, brass, copper, and which, therefore, tend to the formation of blisters or scales, to precede the chromium plating with the plating thereon of a suitable material which closes the pores of the chromium deposit without blistering itself. A metal which satisfies all these requirements is found in nickel. A primary coat of nickel has various disadvantages. Nickel plating in itself offers a certain amount of protection against corroding agents. The only drawbacks of nickel are its discoloration or superficial oxidation. If the nickel plating is followed by a chromium plating, the latter may be applied very thinly. The nickel coat which lies exposed through the pores of the chromium plate is sufficient to protect the base metal. Even if the nickel particles uncovered by the pores of the chromium deposit are somewhat oxidized, these oxides close the pores against further attacks of the corroding agents without in the least affecting the appearance of the chromium plated article.

A further advantage of the primary nickel coat resides in the fact that the coefficient of expansion of nickel is materially lower than that of copper and of its alloys and that thus there is established a certain gradient between nickel and chromium, whose coefficient of expansion is the lowest. This intermediate layer of nickel decreases the tension in the thin chromium film, attenuates its elongation and improves its adhesive properties.

Another advantage of the nickel plate is found in the fact that the presence of the nickel beneath the chromium deposit tends to give to the latter a warmer tone. An objection which has frequently been made to the double treatment with nickel and chromium is that the presence of nickel may tend to mask discontinuities in the chromium coat. Fortunately this is not the case, due to the difference in appearance to the eye of the two metal layers which enables anybody with a fair amount of skill in the art to detect such flaws.

Still another advantage of the primary nickel coating is the improvement of the throwing power of the bath. This improvement may be explained in this that nickel is not attacked by chromic acid, in contradistinction to copper and its alloys, the oxides of which obstruct the deposition of chromium upon recesses.

Last but not least we may mention that after a primary deposition of nickel has been effected upon articles or parts comprising a plurality of different metals, there has been formed a suitable basis for an adherent coat of chromium, whereas without such a nickel plate all such portions of the composite body which are furthest removed are not covered with chromium but are easily attacked by chromic acid or have a comparatively low hydrogen potential. After the nickel plating the articles or parts are simply treated as if they were entirely made of nickel.

We may state that nickel and its alloys are particularly easily chromium plated by a direct process. Nickel is particularly resistant to chromic acid solution, so that finishing operations, which not only are time consuming, but may destroy the chromium plate, are no longer required.

Essential requirements of the primary nickel coat are that it sufficiently covers the base metal, that it is impermeable, that it has sufficient adhesive power to avoid any scaling off from it; the latter property in particular is one not usually possessed by nickel plated commercial articles.

As has been stated above it is not advisable to chromium plate steel, iron, copper and its alloys without a primary nickel coat. Only such parts which are very plain and free from recesses and which, in addition, are not to be subjected to particular stresses when in use, such as for instance film reels, may be advantageously chromium plated in a direct process.

A special case of chromium plating is to be found in the coating of oil tanks. About 60 large oil tanks were chromium plated directly, without a primary coat of another metal, in San Francisco. The tanks were 3 m. in diameter and 13 m. in height. Their walls had a thickness of 50 mm. and were made of sheet steel. In one year corrosion reduces this thickness to 32 mm. The chromium plating of one of these tanks took 10 days and the amount of electrolyte was about 120 cubic meters. After 2 years' use it was not possible to find any trace of corrosion.

As to the field of application of bright chromium plating with special reference to its protection against corrosion, it may be said that this type of treatment may be advantageously applied wherever nickel plating was used up to the present, not so much as a substitute for nickel plating, but rather as an improvement upon the nickel plating.

A decided advantage of chromium plated parts as compared with nickel plated parts lies in the permanency of the luster. A silver treated mirror reflects about 85% of the light, a nickel mirror about 65% and a chromium mirror about 56%. If these three mirrors are subjected to the effect of industrial air containing an equal amount of humidity, the differences in the reflective powers are equalized in about eight days, and after about three weeks the chromium mirror shows its original reflective power, while the silver mirror and the nickel mirror exhibit a reflective power of only about 50%. It is thus seen that a saving is effected when chromium is used, not only in the material but also from the standpoint of cleaning and maintaining, since it is sufficient to remove the dust and grime from time to time without its being necessary to resort to polishing with the aid of commercial cleaning agents.

Difficulties

A difficulty is encountered in the treatment of composite or strongly porous articles, due to the washing of the residues. In nickel plating small amounts of such residues may be left to evaporate since the remaining salt is of no further consequence. The chromium solution, however, leaves chromic acid which is strongly hygroscopic and which consequently never dries out entirely. In the treatment of porous castings it is often experienced that after several hours of intensive lixiviation there is still an exudation from the pores, see Fig. 11.

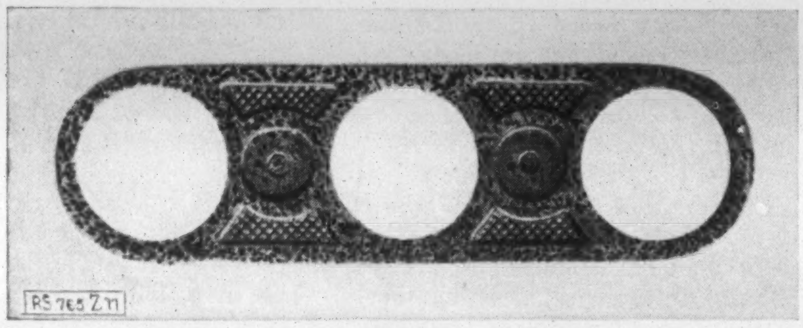


Fig. 11—Poorly Washed Porous Casting

The adhesive power of the chromium plate upon chromium as a base is very poor, an observation similar to what is experienced in nickel plating. If a chromium plating on chromium is necessary it is essential to pickle off the first deposit in all cases in which the part is to be tested as to its power of adhesion to the chromium layer. Even other deposits such as nickel may not be easily and satisfactorily applied upon a layer of chromium, apparently owing to the cathode polarization and the ensuing activity of non-oxidizing electrolytes which cause an attack upon the chromium base and the formation of a layer of oxide which tends to weaken the adhesive power of the chromium to the metals deposited upon it.

Difficulties of a peculiar nature are encountered in the chromium plating of brass and other copper alloys. In a great many cases, if not always, and usually after about 3 months, without any particular cause or reason, a scaling off of the chromium deposit occurs. To my mind the theory that the base metal has been oxidized through the pores of the chromium deposit and has thus caused the scaling off, is untenable, since this scaling off usually takes place only 3 months after the chromium plating and always irrespective of whether or not the parts were subjected to the effects of corroding agents. The scaling off in question presents an appearance entirely different from that caused by insufficient covering or by a particular type of stresses and strains encountered. I am of the opinion that this phenomenon is caused by inter-crystalline transformations of the alloys since, apart from the critical period of from 2 to 3 months, there is no indication and no connection tending to implicate the chemical composition of the material, the prior treatments, the chromium plating treatment, etc. This difficulty, however, has been obviated by the advent of the treatment including a primary nickel plating; the question is of a secondary practical importance and has only a certain amount of scientific interest.

A further difficulty is found in the supervision of the plating baths. Owing to the intensive coloration of the bath and its strong acid and oxidizing properties, the practical supervision must of necessity be narrowed down to that of the specific gravity. It is impossible to use so-called reaction papers, the use of which is so common in the supervision of nickel baths. Since, however, the composition of the solution must be maintained constant within certain limits, it is necessary to effect the supervision by analysis, a procedure possible only in especially suitable laboratories, and to correct the solution if necessary.

Among other problems encountered in chromium plating, the solutions of which appear to be of particular practical interest, we may mention here soldering and welding of chromium plated articles as well as the simultaneous plating of a great number of articles in drums.

Conclusion

Chromium plating so far has not developed into the sole protective plating process against corrosion, to the exclusion of all others, as had been expected in the beginning. However, by the expedient of a primary plating process which has overcome most of the obstacles of a practical nature, chromium plating has succeeded in establishing itself securely in the anti-corrosion industry; it has become a valuable and indispensable industrial process. As an anti-corrosion process in the ordinary sense it is no substitute for nickel plating but rather an auxiliary which successfully supplements the usual nickel plating process in essential points and improves and refines the other known electroplating processes.

New Automatic Welding Electrode Feeding Device

The General Electric Company announces an improved feeding device on its automatic welding head to meet advances in the art of automatic welding which call for an increased use of high welding speeds requiring heavier welding currents and larger sizes of electrode wire than heretofore ordinarily used. This improvement consists of the addition of geared drive to what was formerly the idler roller in the feeding mechanism. In this way the large sizes of wire, which are stiff and hard to feed without excessive pressure on the driving rolls, are positively fed without slippage, at a regular rate and with only a moderate pressure between the driving rolls.

This device also extends the uses for automatic welding by making it now possible to use curved nozzles so as to reach into otherwise inaccessible places, and to weld in abnormal positions. Such cases were formerly considered impractical if not impossible on account of the difficulty of conforming the heavier wires to any other shape than their natural curvature as they come from the reel.

For the majority of applications the present practice in automatic welding requires electrode sizes from $^1/_8$"–$^1/_4$" diameter. The improved drive roll gears furnished on heads for these normal applications will accommodate any size wire from $^1/_8$"–$^1/_4$" diameter without changing gears. Below $^1/_8$" the gears are not needed and it is only necessary to remove one gear—that on the drive roll shaft. Sufficient pressure can then be obtained for these small sizes of wire, by screwing down the adjustment on the binding roll.

Advise Against Aluminum Motor Truck Tanks Until Tests Demonstrate Safety

A resolution advising against the use of aluminum for construction of motor truck tanks carrying flammable liquids until comprehensive tests demonstrate the material can be employed with safety was adopted by the Committee on Flammable Liquids of the National Fire Protection Association at a meeting January 21. E. J. Smith, of the Underwriters' Laboratories, was appointed chairman of a sub-committee instructed to cooperate with the American Petroleum Institute, Underwriters' Laboratories and manufacturers of aluminum in a test program and to report in full with recommendations.

Seventeen representatives of oil companies, aluminum manufacturers, fire prevention interests and state inspection bureaus met with 19 members of the committee. Data was submitted to show that use of aluminum for the purpose would permit a 50% saving in weight and would increase tank truck pay load capacities 20 to 25%. Saving in weight was held to be the chief advantage. Objections were raised because of the increased danger in case of fire. A telegram from the Eastern Group, American Petroleum Institute Committee on Automotive Transportation, urged that everything be done to encourage the use of aluminum and that all research facilities be afforded in order to develop needed data definitely to determine if it be feasible.

Other members of the sub-committee are: W. E. Cooper, Bureau of Explosives; R. W. Black, Standard Oil Development Co., New York; C. B. Langdon, Factory Insurance Association; and D. V. Stroop, American Petroleum Institute Engineer.

Book Reviews

Der Einfluss von Oberflächenbeschädigungen auf die Biegungsschwingungsfestigkeit. By W. Zander. Verlag N. E. M., Berlin, 1929. Paper, 6 × 9 inches, 65 pages. Price, 5 R. M.

Since 1916 the testing materials laboratory at the Technische Hochschule, Braunschweig, Germany, has carried on investigations on the fatigue of metals. The author in his careful work applied the "Biegungsschwingungsmaschine," as developed in the institute and examined ferrous as well as non-ferrous materials. The publication which in many respects enlarges our knowledge on this critical question will be of interest not only to the research engineer from a scientific viewpoint but also to the machine designer and construction engineer who must take the decrease of physical properties due to surface defects into account. Three kinds of improved duralumin (55,180–60,160 lb./in.^{2} tensile strength), a low carbon steel (C: 0.11%, Mn: 0.46%, Si: 0.26%, P: 0.011%, S: 0.007%) and 2 treated alloy steels (3.9% Ni, 0.8% Cr and 3.38% Ni, 11.36% Cr, 0.52% Mo, 1.07% W) were tested. The defects of the surfaces of the test pieces were produced artificially by various means, the depth of the defect was accurately measured during the course of the tests. Scratches with hardened steel points, diamonds, razor blades, files, cutting steels, chisels, grinding disks and friction saws were made before testing. As regards the results, duralumin seems to prove less sensitive to defects than steel. The reduction of fatigue strength by defects was found with duralumin to be in general about 30% (16–39%). The corresponding maximum and minimum figures for the steels are: (low C-steel: 29.5–49.5%, Ni-Cr steel: 15–54%, Mo-W steel: 27–64%). Of interest is the author's statement that the sensitivity of surface does not increase with the depth and sharpness of the defect, but depends essentially on how the injury occurred.—G. Neuendorff.

Der Einfluss von Oberflächenbeschädigungen auf die Biegungsschwingungsfestigkeit. By R. Günther. Verlag N. E. M., Berlin. Paper, 6 × $8^{1}/_{4}$ inches, 68 pages, 11 tables. Price, 5 R. M.

R. Günther, in his publication, presents investigations which are a continuation of Zander's test and therefore he carried on his work along the lines laid down by Zander. Furthermore, he paid attention to the question of the relations between sensitivity of surface and damping. Bronze, cast iron, low carbon steel, Mn-Ni steel, Cr-Mn steel, Cr-Ni steel and Si steel were tested. The surface defects were produced according to Zander's method. The reduction of the fatigue strength amounted to 27–57.5% for bronze, 6–33% for cast iron, 27–48% for C-steel, 12–56.5% for Cr-Mn steel, 18–54% for Mn-Ni steel, 21–54.5% for Cr-Ni-W steel and 21–54.5% for Si steel. The results on the one hand prove the small sensitivity of cast iron for surface defects and the high sensitivity of bronze on the other hand. Since it is most important to have more data available on this field it is hoped that the investigations will be continued and extended to all main construction materials.—G. Neuendorff.

Eine Dauerbiegmaschine mit Schwingendem in der Messstrecke gleichmässig beanspruchtem Probestab. By G. S. von Heydekampf. Verlag N. E. M., Berlin. Paper, 6 × 9 inches, 40 pages. Price, 4 R. M.

Heydekampf's publication is essentially a review of the investigations of Zander and Günther, insofar as he critically examines the machines for fatigue tests developed up to the present and clearly outlines the rules for their construction. In the introduction the author gives the conditions which a dynamic testing machine must fulfill and then reports his investigations of the fatigue bending machine as built and used by the Wöhler Institute in Braunschweig. All individual parts of the machine are described in detail and were carefully checked by tests. It was found that the mentioned rules are fulfilled by the machine. In conclusion the author claims that the machine will be especially suited to give information on the behavior of materials subjected to alternating bending stresses.—G. Neuendorff.

Metal Pickling. By E. E. Wynn. Charles Sever, Ltd., Manchester. 32 pages. Price, 2 s. 6 d.

Although metals have been submitted to pickling operations for many years it is curious that no previous writer has found the subject worthy of exposition. Perhaps the absence of scientific explanation and the deep-rooted prejudices existing in the old-time shop contributed to the neglect. He has provided a straightforward description of the processes involved without confusing the issue with technicalities. While no new thoughts are introduced there are some pertinent references to the action of inhibitors and recommendations upon the treatment of special steels. The suggested methods of maintaining control of the composition of the liquid baths and of the temperature should prove particularly useful to the small shop which cannot afford to retain a laboratory.—Francis M. Turner, Jr.

Gauges and Fine Measurements. F. H. Rolt. MacMillan Company, New York, 1929. Cloth. Vol. I. Standards of Length, Measuring Machines, Comparators. 366 pages, 253 figs. Vol. II. Limit Gauges, Measuring Instruments, General Methods of Measurements. 357 pages, 353 figs. 6 × 9 inches. Price, $14.50.

The instruments used for the measurement of parts during manufacture have passed through various periods of development. The earliest one was marked by the use of an ordinary wooden scale together with whatever other devices were at hand or could be supplied by the ingenuity of the machinist. This was followed by the use of the steel scale and the caliper. Next came the use of micrometers and specially designed mechanical measuring tools. Then optical apparatus opened an avenue for the accomplishment of many measurements heretofore deemed impossible.

Up until the second half of the 19th century, the greatest accuracy of measuring tools was 0.005″, up to the beginning of the 20th century this was increased to 0.0005″, and now instruments are available, which are capable of measuring to an accuracy of 0.000001″. It may come as a surprise to many that measurements of this accuracy are a practical necessity to meet the requirements of industry.

With a greater appreciation of the advantages of accurate measurement has come a steady demand for further development and new methods and applications are continually being evolved. The present time marks a fairly well-defined stage in the evolution of suitable methods and devices for measuring with speed and precision.

These volumes, based on the author's article on "Gauges" in the Dictionary of Applied Physics are, therefore, appropriate as they take stock of the present status of this subject. Very excellent bibliographies are given at the end of each chapter, which will permit looking further into each of the divisions treated. The foreign and domestic literature is represented in the references, a point for which the author is to be commended. Appendices contain a considerable amount of amplifying information, including specifications of the wave-lengths commonly used in optical interference measurements, information of standardized equivalents in decimals of an inch for the various gage numbers, notes on the testing of a circular dividing machine, etc.

A knowledge of the principles and methods employed in fine measurements is of the first importance in every modern tool room, research laboratory, etc., and these two volumes, therefore, fill a decided need.

The mechanical engineer, the instrument designer, the machine-tool builder and the machine-tool user will find these books of immediate value. They open a broad field of information backed by the high standing of the author.

Precision measuring tools on the market are covered without partiality as to country, American and German instruments are covered together with the English. Only one omission was noticed in the case of measuring machines, linear and circular dividing machines and measuring microscopes, no mention is made of the Gaertner Scientific Corporation (Chicago).—R. R.

Outline of Metallurgical Practice. By Carle R. Hayward. D. van Nostrand Company, Inc., 1929. Cloth, 612 pages, 410 figs., 66 tables. Price, $7.50.

The author clearly states in his preface that the book is first intended to meet the need of many engineers for a quick reference book, which will give modern practice in extracting and refining most of the metals and which will give general information regarding the sources, uses and important alloys of the metals and second to assist students who are starting their metallurgical studies with no practical experience and little knowledge of the subject or its literature.

The writer attained this goal with remarkable skill and is to be commended for the clearness in presentation of the subject. The following metals are dealt with: Cu, Pb, Zn, Al, Ni, Sn, Hg, Sb, As, Bi, Cd, Co, Mg, Au, Ag, Pt, Cr, W, Mn, V, Mo, Fe and steel. The book concludes with non-ferrous alloys. The latest status of metallurgical practice is taken into consideration although the author mainly restricts himself to American practice. According to their importance the different metals are treated more or less comprehensively, in that Cu and Fe are considered in about 115 pages each, Al in only 15 pages and Au in about 50 pages. It must be mentioned that the most important literature in English is referred to at the end of each chapter. The collection of the principal physical, mechanical and chemical properties in the same place will furthermore be very much appreciated by the reader. An especially important feature of the book is the illustrations which are liberally contributed by leading American companies, thus enabling the author to accomplish successfully what he promised in the preface. Again, it is only aluminum which is sadly neglected. The chapter on non-ferrous alloys which is cut down to 36 pages is very short and does not contain interpretations of the diagrams presented.

In future editions the author no doubt will bear in mind that his book will be studied abroad as well as in this country. A more international character could be attained by slight modifications and by considering to a greater extent the metallurgical practice of other countries. The Wälz- and the Balz-process for instance are not mentioned. But as a whole the book can well be recommended to students and to the specialists in any branch of metallurgy who wish to obtain a general picture of those branches of the subject with which they are not familiar.—E. Fetz.

Actualites Metallurgiques. By Pierre Dejean with a preface by Albert Sauveur. Dunod, Paris, 1925. Paper, $6\frac{1}{2} \times 9$ inches, 284 pages, 144 figs. Price, 50 Fr.

A set of ideas which is considered preposterous to-day might have all known invectives hurled at it to-morrow, begin to be skeptically considered a day after, and blossom forth into the foundation of a new school of thought when somebody, usually a German professor, manages to straighten its kinks and to fasten elusive facts where they belong.

The possibility of troostite formation before austenite begins to decompose into martensite introduces a major change into the present conception of iron carbon equilibria. This hypothesis being advanced by Prof. Dejean in one of the chapters of this book cannot fail to excite the imagination and interest of contemporary metallurgists. It takes a great courage and conviction to stake one's reputation in advancing ideas basically opposite to the commonly accepted, though one may rest assured that they will meet a most cordial reception from the leaders of metallurgical thought, from all those who are broad enough to be willing to disregard any preconceived notion if this can lead to the further advancement of their science.

One cannot prevent feeling, however, that the point of Prof. Dejean would gain considerably were his experimental evidence much more comprehensive and systematic than the procedure described in Chapter III.

Being a compilation of papers written at different dates the book varies strongly in quality from chapter to chapter, from a thorough treatment of the methods available for determination of critical points in metals and the lucid presentation of almost modern viewpoints on the mechanism of hardening, found respectively in Chapters I and IV, to a rather indifferent handling of high copper-nickel-chromium steel at the beginning of Chapter III and in the following paragraphs.

Without bringing any new facts or data the book furnishes much food for thought and a few hours of pleasant reading.—John D. Gat.

Vom Erz zum metallischen Werkstoff. By Dr. W. Guertler and W. Leitgebel. Akademische Verlagsgesellschaft m. b. H., Leipzig, 1929. Cloth, 6 × 9 inches, 426 pages, 176 figs., 30 tables. Price, 32 R. M.

The publication of this book fills an urgent need for a summary of the known facts on metallurgy and science of metals. An often observed fact is that the knowledge of metallurgical engineers in allied fields is limited. Since it may be partly due to the tremendous progress, the more so will the book fulfill its mission. From the title, we can expect to find extensive information. In as condensed form as possible the authors deal, first, with the general characteristics of ores, metals and alloys; second, with ore dressing, production of metals, refining, alloying including welding and soldering, shaping in the liquid and solid state, improvement. These chapters of technical processes are followed by a representation of the more important physical and chemical principles of metallurgy. In the final chapter of almost 100 pages, the most important physicochemical data are presented.—G. Neuendorff.

Agenda Dunod 1930 "Metallurgie." By A. Roux. 46th edition. Dunod, Paris, 1930. Cloth, 4 × 6 inches, 504 pages, 55 figs. Price, 20.50 francs.

The present volume can be considered as the leading French metallurgical handbook. Being published yearly it aims to incorporate the most recent developments of the art and to bring its statistical data as close up to date as possible.

The plan of the book embraces general metallurgy in all its phases, the metallurgy of different metals including precious and semi-rare, testing in all its modifications, heat treatment, metallography, an ample supply of statistics and the usual reference tables. A somewhat unusual feature for a work of this type, 70 pages on labor legislation, would appeal to the student of industrial relations. In his treatment of the individual subjects the author succeeds in being succinct but clear. The position occupied by him lies between the viewpoint of a scientist and the mill man.

For an American reader the book can be valuable by giving correct information regarding the state of French metallurgical industries besides serving as a handy source of metallurgical data for daily use. None of the English handbooks on the subject manages to compress so much variegated and reliable information in such a small volume of type. One, however, cannot omit to point at two major peculiarities detracting from the value of the book. Statistical data in some cases reach 1927, while in the others they lag a decade, as is the case of the development of the Bessemer process when they end with 1913, though the industrial importance of the process is not by any means terminated even at the time of this writing. The book is written for French metallurgists so that the home industries and practice predominate to the extent of the practical exclusion of the foreign.—John D. Gat.

Taschenbuch für Berg- und Hüttenleute. By Dr.-Ing. F. Kögler. Wilhelm Ernst & Sohn, Berlin, 1929. Second enlarged edition. Cloth, $5\frac{1}{4} \times 7\frac{1}{4}$ inches, 1207 pages, 630 figs. Price, 33.50 R. M.

Engineering handbooks are often called bibles in Germany and it can be stated that in the case of this handbook, mining and metallurgical engineers can well call this their bible. The book covers the whole field of mining and metallurgy, with the exception of ferrous metallurgy. American engineers will obtain some idea as to what German mining and metallurgical students are taught. In 35 chapters are covered mineralogy, geology, theory of ore deposits, prospecting, deep drilling, stripping, mining methods, extraction, safety measures, mining of lignite, dressing, briquetting of ores, coking of coal, mining of potash, organization of mines, accident prevention, surveying, mining laws, damages in mining, mining materials, fuels and combustion, steam power plants, combustion engines, extraction machines, pumps, compressors, blowers, ventilators, electricity, blowpipe testing, technical testing of metals, general metallurgy, non-ferrous metallurgy, electro-metallurgy and light metal alloys. The book considers the latest developments in the fields covered and has been written by the best German authorities. Therefore, it is not necessary to especially recommend it.—G. Neuendorff.

Patent Department

Through an arrangement with Mr. W. M. Corse, Metallurgical Engineer, Washington, D. C., who operates a well-known Patent Information Service, we are able to publish every month a list of important patents in the metallurgical field from the United States, Canada and Europe. The following countries will be included in the European listing: England, Germany, France, Switzerland, Denmark, Norway, Sweden and Italy.

If our readers wish more information about any of the patents listed below they can get it by writing to our Patent Department, and mentioning the fact that they have seen the reference in METALS & ALLOYS. *We will be prepared to mail copies of United States Patents to clients within twenty-four hours of date of issue by special arrangement. Photostatic copies, translations of claims and of full text of foreign patents will be supplied if desired.*

This service is furnished under special arrangement with Mr. Corse's organization at most reasonable rates. Full information can be secured by writing to Patent Department, METALS & ALLOYS, *419 Fourth Avenue, New York.*

United States Patents

Subject of Invention, Patentee, Patent No. and Filing Date.

Method of treating minerals containing potassium, aluminum and iron. C. E. Arnold, assignor to Electro Company, Odessa, Del. No. 1,742,191. Feb. 19, 1925.

Metal-coating apparatus and method. C. W. Owston, assignor to McCord Radiator & Mfg. Co., both of Detroit, Mich. No. 1,742,214. Feb. 19, 1925.

Electrical resistor, conductor, and the like. J. Kelleher, Chippewa, Ontario, Canada, assignor to Harper Electric Furnace Corp. No. 1,742,259. July 17, 1925.

Method of separating tin compounds from solutions. H. M. Schleicher, Monterrey, Mexico, assignor to American Metal Co., Ltd., New York, N. Y. No. 1,742,284. Nov. 6, 1925.

Electrical furnace. H. N. Shaw, Milwaukee, Wis., assignor, by mesne assignments, to Globar Corp., Niagara Falls, N. Y. No.1,742,286. Sept. 3, 1925.

Production of metal alloy and of articles made thereof. W. Schrobsdorff, Berlin-Westend, Germany. No. 1,742,417. July 18, 1927.

Metallurgical furnace. F. A. J. Fitzgerald, Niagara Falls, N. Y., and J. Kelleher, Chippewa, Ontario, Canada, assignors to Titania Corp., Los Angeles, Calif. No. 1,742,441. July 24, 1928.

Continuous-electric-arc welding. A. J. Hand, assignor to California Corrugated Culvert Co., both of Berkeley, Calif. No. 1,742,469. Feb. 15, 1927.

Method of manufacturing steel. J. K. Smith, Detroit, Mich., assignor to Granular Iron Company. No. 1,742,487. Feb. 11, 1928.

Non-corrosive aluminum alloy. R. S. Rainer, Neckarsulm, Germany, assignor to American Lurgi Corp., New York, N. Y. No. 1,742,557. Feb. 24, 1926.

Furnace. C. E. Buysse, assignor to Industrial Heating Equipment Co., both of Detroit, Mich. No. 1,742, 646. Mar. 19, 1928.

Conveyer for use with furnaces. H. A. Cartwright, assignor to The Surface Combustion Co., Inc., both of Toledo, Ohio. No. 1,742,647. May 18, 1928.

Drawing press. R. B. Treer, assignor to The Toledo Machine & Tool Co., both of Toledo, Ohio. No. 1,742,673. Sept. 23, 1926.

Molding machine clamping apparatus. G. C. Batten, Cincinnati, O. No. 1,742,681. May 31, 1929.

Mold-drying apparatus. L. F. Nock, Elyria, Ohio. No. 1,742,721. Aug. 25, 1927.

Device for retaining the flue dust in blast furnaces. J. Stoecker, Bochum, Germany. No. 1,742,733. Feb. 8, 1929.

Tempering machine. B. H. Urschel, Bowling Green, O. No. 1,742,739. Oct. 31, 1928.

Production and utilization of carbon monoxide. L. Bradley, Montclair, N. J. No. 1,742,750. Apr. 7, 1926.

Heat treatment of metals. A. A. Somerville, Flushing, N. Y., assignor of two-thirds to R. T. Vanderbilt Co., Inc., New York. No. 1,742,791. July 15, 1926.

Method for making high-speed-steel tool castings. A. C. Davidson, assignor to Dycast Steel Co., a Co-partnership composed of A. C. Davidson and H. W. Henke, all of Collinsville, Conn. No. 1,742, 849. Dec. 27, 1924.

Steel. W. C. Hamilton and C. E. Sims, assignors to American Steel Foundries, all of Chicago, Ill. No. 1,742,857. Dec. 3, 1927.

Sheet-metal press. F. J. Rode and J. H. Jochum, Jr., Chicago, Ill. No. 1,742,877. Mar. 18, 1929.

Inhibitor. H. P. Corson, Lakewood, O., assignor, by mesne assignments, to Grasselli Chemical Company, Cleveland, O. No. 1,742,986. Aug. 9, 1928.

Rolling metal articles. F. W. Trabold, Alliance, O. No. 1,743,008. Oct. 6, 1926.

Roll grinder. H. E. P. Taylor, Seymour, Conn., assignor, by mesne assignments, to Farrel-Birmingham Co., Inc., Ansonia, Conn. No. 1,742,736. Nov. 22, 1926.

Magnetic material. A. F. Bundur, Berwyn, Ill., assignor to Western Electric Co. Inc. No. 1,743,089. Apr. 26, 1928.

Magnetic separator. R. S. Riley and F. Walton, assignors to Riley Stoker Corp., all of Worcester, Mass. No. 1,743,237. March 29, 1926.

Method and apparatus for making sand cores. F. H. Morehead, Boston, Mass. No. 1,743,281. Feb. 8, 1928.

Alloys. F. W. Andrews, Dayton, Ohio, assignor, by mesne assignments, to Frigidaire Corp. No. 1,743,303. Apr. 28, 1927.

Method of and apparatus for forge welding cylinders and the like. J. Barrow, Columbiana, Ohio. No. 1,743,307. Nov. 13, 1928.

Alloy of steel and method of treating the alloy. C. P. Beath, La Grange, and B. J. Babbitt, Riverside, Ill., assignors to Western Electric Company, Inc., New York, N. Y. No. 1,743,309. November 19, 1927.

Founding apparatus. H. H. C. Grondahl, Chicago, Ill., assignor to Western Electric Company, Inc., New York, N. Y. No. 1,743,341. September 3, 1926.

Bending machine. A. T. Yates, assignor to Buffalo Forge Co., both of Buffalo, N. Y. No. 1,743,418. Oct. 3, 1927.

Molding machine or apparatus. A. A. Landon, Buffalo, and S. C. Bliss, Kenmore, N. Y., assignors to American Radiator Company, New York. No. 1,743,462. Feb. 14, 1924.

Flotation Process. J. H. Lane, Venice, California. No. 1,743,463. August 3, 1927.

Apparatus for removing oil from metal. O. L. Maag and C. M. Maratta assignors to The Timken Roller Bearing Company, all of Canton, Ohio. No. 1,743,465. August 13, 1925.

Apparatus for making sand cores. F. H. Morehead, Boston, Mass. No. 1,743,473. Feb. 8, 1928.

Process of treating aluminum with halogen gases. R. J. Anderson, assignor to Fairmount Manufacturing Co., all of Fairmount, W. Va. No. 1,743,515. May 1, 1928.

Separation process and apparatus. C. T. Cabrera, Philadelphia, Pa., assignor to Electro-Dialyzer Corp. No. 1,743,524. Nov. 15, 1927.

Filtering medium. C. T. Cabrera, New York, N. Y., assignor to Electro Dialyzer Corp., New York. No. 1,743,525. June 1, 1928.

Converter. G. Jakova-Mertu-Ri, Gagny, France, assignor to La Carbonisation, Société Generale d'Exploitation des Carbones, Paris, France. No. 1,743,561. Jan. 3, 1929.

Casting and method of making the same. H. Perry, Brooklyn, N. Y., assignor of one-half to J. M. Cole, New York, N. Y. No. 1,743,567. July 24, 1926.

Ram for metal-extrusion presses. N. A. Robertson, assignor to J. Robertson Co. Inc., both of Brooklyn, N. Y. No. 1,743,687. April 8, 1926.

Soldering machine. S. L. Casella, New York, and O. K. Reinhardt, Jamaica, N. Y., assignors, by mesne assignments, to Bond Electric Corporation, Jersey City, N. J. No. 1,743,755. Sept. 7, 1927.

Electrical contact. T. S. Fuller, Schenectady, N. Y., assignor to General Electric Company. No. 1,743,768. Sept. 16, 1926.

Light metal alloy. J. A. Gann, Midland, Mich., assignor to The Dow Chemical Company, Midland, Mich. No. 1,743,849. July 26, 1926.

Pyrometer well. F. M. Poole, Tulsa, Okla., assignor to The Brown Instrument Company, Philadelphia, Pa. No. 1,743,867. April 27, 1927.

Electric smelting of zinc ore. E. C. Gaskill, Red Bank, N. J., assignor to St. Joseph Lead Co., New York, N. Y. No. 1,743,886. Nov. 17, 1926.

Ingot mold. R. C. Reed, Youngstown, Ohio. No. 1,743,932. Sept. 20, 1928.

Gage for positioning chills or cores on sand molds. W. B. Robe, Towson, Md., assignor to G. S. Sloan as trustee for Egal Metal Products Co., Baltimore, Md. No. 1,743,933. Nov. 19, 1928.

Induction furnace. P. E. Bunet, Versailles, France, assignor of one-half to Société Aciéries de Gennevilliers, Gennevilliers, Seine, France. No. 1,743,956. May 25, 1928.

Rolling metal strip. A. P. Steckel, assignor to The Cold Metal Process Company, both of Youngstown, Ohio. No. 1,744,017. September 13, 1923.

Refractory structure and article and method of forming the same. F. I. Arensberg, Pittsburgh, A. J. Jackman, Forest Hills, and C. L. Jones, Pittsburgh, Pa., assignors to Vesuvius Crucible Company, Swissvale, Pa. No. 1,743,803. Aug. 21, 1928.

Pneumatic flotation machine. R. Lord, Culver City, Calif., assignor to Southwestern Engineering Company, Los Angeles, Calif. No. 1,743,926. Sept. 1, 1926.

Metal rolling. A. P. Steckel, assignor to The Cold Metal Process Company, both of Youngstown, Ohio. No. 1,744,016. June 30, 1923.

Process of recovering oil from metal. O. L. Maag and C. M. Maratta, assignors to The Timken Roller Bearing Co., all of Canton, Ohio. No. 1,743,466. Apr. 13, 1927.

Soldering process. J. H. Nead, E. R. Wehr and C. C. Mahlie, assignors to The American Rolling Mill Company, all of Middletown, Ohio. No. 1,743,615. Feb. 25, 1927.

Method and apparatus for rolling. A. P. Steckel, assignor to The Cold Metal Process Company, all of Youngstown, Ohio. No. 1,744,018. June 20, 1927.

Electrical welding machine. A. C. Taylor, Warren, Ohio. No. 1,744,062, May 20, 1926.

Apparatus for extruding tubes. C. S. McChesney, Kenmore and H. H. Clark, Buffalo, N. Y., assignos to Dunlop Tire and Rubber Corp., Buffalo, N. Y. No. 1,744,130. Mar. 19, 1928.

Process of obtaining lead from its ores or other compounds. G. L. Oldright. Salt Lake City, Utah. No. 1,744,174. Nov. 22, 1926.

Smelting of ferro-alloys in blast furnaces. F. W. Davis, Milford, Del., assignor to S. G. Allen, trustee. No. 1,744,213. June 2, 1924.

Method of treating alloys. N. B. Pilling, Elizabeth, N. J., assignor to Westinghouse Electric & Manufacturing Co. No. 1,744,242. Aug. 23, 1926.

Apparatus for handling articles subjected to a galvanic action. C. J. Lemont, South Milwaukee, Wis., assignor, by mesne assignments, to Line Material Co., Milwaukee, Wisc. No. 1,744,273. Jan. 25, 1926.

Method of applying a firmly-adhering metal coat to insulating plates, particularly for use in electric condensers. E. Pfiffner, Fribourg, Switzerland, assignor, by mesne assignments, to Radio-Patents Corp., New York. No. 1,744,281. Nov. 11, 1926.

Welding and forging by electric-resistance method. F. H. Speed, Lynn, Mass., assignor to Thomson Electric Welding Co. No. 1,744,284. Sept. 26, 1927.

Manufacture of stainless iron. W. M. Farnsworth, Canton, O., assignor to Central Alloy Steel Corporation, Massillon, O. No. 1,744,374. June 29, 1927.

Plate-bending machine. P. M. Kuehn, assignor to The Bartlett Hayward Co., both of Baltimore, Md. No. 1,744,391. Dec. 18, 1924.

Electrode-cooling coil. E. Lunn, assignor to Pullman Car and Manufacturing Corp. both of Chicago, Ill. No. 1,744,399. Sept. 10, 1927.

Manufacture of steel. E. C. Smith, assignor by mesne assignments, to Central Alloy Steel Corp. both of Massillon, O. No. 1,744,418. Feb. 16, 1925.

Method of filtering cyanide slimes and apparatus for use in same. C. Lintecum, Tonapah, Nev. No. 1,744,480. Sept. 3, 1924.

Aluminum alloy. H. C. Hall, Littleover, Derby, and T. F. Bradbury, Derby, England. No. 1,744,545. Mar. 27, 1929.

Refractory material. A. Hasselbach, assignor to the Firm G. Polysius, both of Dessau, Germany. No. 1,744,547. Feb. 26, 1926.

Mold. O. S. Papazian, New York, N. Y. No. 1,744,571. Aug. 13, 1928.

Temperature regulating attachment for linotype machines and similar purposes. E. S. Halsey, Washington, D. C. No. 1,744,631. July 27, 1927.

Production of strip steel. H. P. Parrock, Brookline, Mass. No. 1,744,670. Mar. 18, 1927.

Welding segments of hollow articles. J. B. Murray and T. E. Murray, Jr., Brooklyn, N. Y. Reissue Patent No. 17,574. (Original No. 1,492,258, filed July 24, 1923.) December 1, 1925.

Alloy wire. W. H. Basset, Cheshire, Conn., assignor to The American Brass Company, Waterbury, Conn. No. 1,744,717. June 18, 1928.

Pilgering mill. O. Bamberger, Duisburg, Germany, assignor to Deutsche Maschinenfabrik Akt.-Ges., Duisburg, Germany. No. 1,744,731. Mar. 25, 1926.

Chain link. J. L. Hogberg, Attleboro, Mass., and J. A. Granskog, Hills Grove, R. I., assignors to General Chain Co., Providence, R. I. No. 1,744,765. June 18, 1925.

Flux. J. McDonough and L. Norman, Chicago, Ill., assignors to Western Electric Co., Inc., New York, No. 1,744,784. May 18, 1927.

Device for separating and concentrating ores. A. W. McTaggart, Anyox, British Columbia. No. 1,744,785. July 21, 1927.

Method of joining together plates or the like. G. Meier, Corapolis, Pa. No. 1,744,786. Feb. 17, 1928.

Method of and apparatus for welding. C. L. Pfeiffer, Chicago, Ill., assignor to Western Electric Co., Inc., New York. No. 1,744,797. Oct. 3, 1927.

Electroplating apparatus. J. G. Newey and C. B. Jerred, Birmingham, England. No. 1,744,792. Sept. 20, 1927.

Machine for surfacing sheets. L. Schulte, Cleveland, O., assignor by mesne assignments, to Allegheny Steel Co., Brackenridge, Pa. No. 1,744,808. Apr. 26, 1926.

Method of producing electrical contacts. J. Shallcross, Chicago, Ill., assignor to Western Electric Co., Inc., New York. No. 1,744,810. June 22, 1927.

Mercury-extracting apparatus. L. Daams, Alhambra, Calif. No. 1,744,827. May 25, 1927.

Method of roasting ores and minerals. M. F. Coolbaugh and J. B. Read, Golden, Colo., assignors to Complex Ores Recoveries Co. No. 1,744,867. June 13, 1924.

Bloom squeezer. W. C. Ely, Terra Haute, Ind., assignor to American Chain Co., Inc. No. 1,744,876. Jan. 7, 1927.

Compensating apparatus for thermoelectric couples. J. J. Carney, assignor to The Bristol Co., both of Waterbury, Conn. No. 1,745,149. Nov. 2, 1927.

Process for coating metal articles with lead. S. Otis and W. T. Herren, Barrington, Ill., assignors to National Boiler Washing Co., of Chicago, Illinois. No. 1,745,185. May 31, 1924.

Mixer for cutting torches. G. C. Quelch, Oakmont, Pa., assignor to International Oxygen Co., Newark, N. J. No. 1,745,190. Sept. 28, 1928.

Automatic forging machine. L. W. Greve, assignor to The Champion Machine & Forging Co., both of Cleveland, O. No. 1,745,214. Nov. 8, 1923.

Coating for welding rods. H. R. Pennington, Chicago, Ill., assignor to Hollup Corp. No. 1,745,267. May 22, 1926.

Bearing alloy. J. V. O. Palm and E. C. Knuth, assignors to The Cleveland Graphite Bronze Co., all of Cleveland, O. No. 1,745,314. Aug. 4,1927.

Pot furnace and the like. P. B. Crocker, assignor to The Sentry Co., both of Taunton, Mass. No. 1,745,335. May 15, 1928.

Welding apparatus. F. A. Sanborn, La Grange, Ill., assignor to Western Electric Co., New York. No. 1,744,804. Oct. 3, 1927.

Grinding and polishing apparatus. L. Schulte, assignor by mesne assignments, to Allegheny Steel Co., Brackenridge, Pa. No. 1,744,807. April 26, 1926.

Apparatus for heat treating articles. C. E. Buysse, Detroit, Mich., assignor to Industrial Heating Equipment Co., Detroit, Mich. No. 1,744,949. Dec. 21, 1927.

Roller conveyer. C. Schulte, Duisburg-Ruhrort, Germany. No. 1,745,030. Oct. 30, 1928.

Method and apparatus for shipping sheet metal. R. T. Romine, Mount Clemens, Mich. No. 1,745,044. Aug. 10, 1926.

Ingot mold and ingot. E. Gathmann, Baltimore, Md. No. 1,745,089. Apr. 3, 1929.

Conveyer Roller. F. E. Moore, Gary, Ind., assignor to American Sheet and Tin Plate Co. No. 1,744,914. Oct. 24, 1928.

Metal pattern and method for making same. A. K. Laukel, Detroit, Mich. No. 1,744,974. Dec. 18, 1926.

Pneumatic casting pump. N. Lester, Worcester, Mass. No. 1,744,975. Apr. 6, 1928.

Inductor furnace. E. F. Northrup, Princeton, N. J., assignor to Ajax Electro-thermic Corp., Ajax Park, N. J. No. 1,744,983. Aug. 2, 1928.

Process of separating materials of varying degrees of conductivity. R. Sherer, Mesa, Ariz., assignor of one-half to C. R. Jones, Phoenix, Ariz. No. 1,744,989. July 12, 1928.

Hardening of the heads of railway rails. J. Lukasczyk, Oberpfalz, Bavaria Germany. No. 1,745,023. Oct. 25, 1928.

Method and apparatus for handling metal. R. T. Romine, Mount Clemens, Mich. No. 1,745,050. Mar. 21, 1927.

Apparatus and method for handling metal. R. T. Romine, Mount Clemens, Mich. No. 1,745,054. Sept. 10, 1927.

Method and apparatus for handling material. R. T. Romine, Mount Clemens, Mich. No. 1,745,055. Nov. 10, 1927.

Method and apparatus for shipping metal. R. T. Romine, Mount Clemens, Mich. No. 1,745,056. May 11, 1928.

Method and apparatus for shipping metal. R. T Romine, Mount Clemens, Mich. No. 1,745,057. Oct. 20, 1928.

Concentrator. E. W. Warfield, Rutherford, N. J., assignor of one-half to J. E. Bucher, Buffalo, N. Y. No. 1,745,070. June 9, 1927.

Carburizing process. A. W. Machlet, Elizabeth, N. J. No. 1,745,104. May 6 1927.

Checker brick. W. W. Odell, Minneapolis, Minn. No. 1,745,113. Sept. 25, 1926.

Cutting torch. F. A. Ost, Inglewood, Calif., assignor to E. M. Smith, Los Angeles, Calif. No. 1,745,115. June 7, 1928.

Metal melting-pot. H. E. Scarbrough, Chicago, Ill., assignor to General Electric Co. No. 1,745,120. Apr. 21, 1928.

Austrian Patents

Subject of Invention, Patentee and Patent No.

Patents whose term began on Aug. 15, 1929.

Process for concentrating minerals by flotation. Guggenheim Bros., New York, N. Y. No. 116,143.

Multiple wire-drawing machine. Berkenhoff & Drebes Akt.-Ges., Asslarer-Hütte, Asslar, near Wetzlar, Germany. No. 116,022.

Bright-annealing furnace using a protective gas. Osterreichische Siemens-Schuckert-Werke, Wien, Austria, assignee of J. Schnepf, Nürnberg, Germany. No. 116, 039.

Charging device for tilting melting furnaces, especially electric furnaces. Demag Akt.-Ges., Duisburg, Germany. No. 116,040.

Cooling device for bright-annealing furnaces. Siemens-Schuckert-Werke Akt.-Ges., Berlin-Siemensstadt., Germany. No. 116,048.

Process for influencing the quality of castings, in casting metals having a high-melting point. R. B. Dale, Jamaica, Long Island, N. Y. No. 116,081.

Water-cooled mold for centrifugal casting. J. Holthaus, Gelsenkirchen, Germany. No. 116,088.

Die-casting machine. J. Polak, Prague, Czechoslovakia. No. 116,262.

Process for producing refractory metals, their alloys or oxides in the form of coherent, sintered or fused bodies, in high-vacuum induction furnaces. Westinghouse Lamp Co., Bloomfield, N. J. No. 115,971.

British Patents

(Complete Specifications Accepted.)

Subject of Invention, Patentee, Patent No. and Filing Date.

Manufacture of alloys of iron and aluminium. C. P. Sandberg, O. F. A. Sandberg and N. P. P. Sandberg (trading as Sandberg), and J. W. Bampfylde. No. 322,446. Sept. 3, 1928.

Refractory crucibles. C. J. Brockbank. No. 322,476. Sept. 3, 1928.

Ironless induction furnaces. Hirsch, Kupfer-und Messingwerke Akt.-Ges. No. 307,044. March 2, 1928.

Concentration of copper ores. S. Tucker. No. 322,527. Sept. 7, 1928.

Soldering-irons. E. T. Gee & Sons, Ltd., and J. Kirkham. No. 323.548, Sept. 12, 1928.

Apparatus for making caskets and like hollow articles by galvanoplastic process. G. Rosenqvist. No. 322, 551. Sept. 13, 1928.

Means for electroplating. W. J. Pitt. No. 322,611. Nov. 6, 1928.

Foundry moulding machines. British Insulated Cables, Ltd., and T. W. Bullock. No. 322,728. Oct. 1, 1928. (Divided application on 321,777.)

Methods and apparatus for cleaning articles, particularly metallic goods. Carrier Engineering Co., Ltd., and K. J. R. Robertson. No. 322,797. June 13, 1928.

Graphite anti-oxide paint. J. N. Bacon No. 322,779. July 13, 1928.

Producing electrolytic deposits of chromium which adhere well and penetrate well into any recesses. W. G. Poetzsch. No. 296,988. Sept. 10, 1927.

Shaft Furnaces. Metallges. Akt.-Ges., O. Hubmann and F. Voerkel. No. 322,819. Sept. 15, 1928.

Cleaning of metal articles. Carrier Engineering Co., Ltd., A. Fowler and K. J. R. Robertson. No. 322,858. Nov. 1, 1928.

Method of treating compound steel ingots. H. Kurz. No. 322,940. Jan. 30, 1929.

Electromagnetic separation of complex ores. British Thomson-Houston Co., Ltd. No. 305,102. Jan. 30, 1929.

Manufacture of metal wheel discs. R. Kronenberg. No. 307,706. March 9, 1928.

Electric furnaces. L. W. Wild and Wild-Barfield Electric Furnaces, Ltd. No. 322,975. March 20, 1929.

Automatic machine for producing zinc cylinders for galvanic cells. Thiel Metallwarenfabrik Ges., F. No. 318,539. Sept. 5, 1928.

Manufacture and production of metal carbonyls. J. Y. Johnson (I. G. Farbenindustrie Akt.-Ges.). No. 323,021. Aug. 18, 1928.

Hardening of the heads of railway rails. Eisenwerk-Ges. Maximilianshütte. No. 303,739. Jan. 7, 1928.

Ovens for the heat-treatment of sheet material. Premix Gas Plants, Ltd., and A. Docking. No. 323,023. Sept. 14, 1928.

Manufacture of corrugated tubes. Bromford Tube Co., Ltd., W. W. Hackett and J. J. Reimann. No. 323,058. Oct. 5, 1928.

Cast Iron. British Cast Iron Research Association. A. L. Norbury and E. Morgan. No. 323,076. Oct. 26, 1928.

Alloys. Soc. Anon. Commentry-Four-Chambault et Decazeville. No. 302,249. Dec. 12, 1927.

Austenitic chromium-nickel steel alloys. F. Krupp Akt.-Ges. No. 305,654. Feb. 9, 1928.

Alloy. W. Muller and Olga Prinzessin zur Lippe. No. 305,942. Feb. 11, 1928.

Ore-reducing furnaces. Cayzer Tin Smelting Co. (Proprietary), Ltd. No. 323,159. Jan. 29, 1929.

Production of soldering-mixtures. G. W. F. F. Knoth. No. 309,029. April 3, 1928.

Methods for the protection of articles of iron, steel and cast iron. G. Nobilleau, and J. Guipet. No. 297,832. Sept. 29, 1927.

Electric furnaces. Hereaus Vacuumschmelze Akt.-Ges. and H. Hiemenz. No. 304,646. Jan. 23, 1928.

Magnetic Materials. W. E. Beatty. (Bell Telephone Laboratories, Inc.) No. 323,222. Sept. 24, 1928.

Process and apparatus for rolling sheet metal, particularly thin sheet metal. C. Thiel. No. 310,494. April 27, 1928.

Machines for descaling iron or steel bars. J. Summers & Sons, Ltd., and H. H. Summers. No. 323,283. Oct. 10, 1928.

Electric-melting-furnaces. Electric Furnace Co., Ltd., and D. F. Campbell. No. 323,291. Oct. 17, 1928.

Manufacture of metal billets, bars and the like. F. W. Harbord and V. Harbord. No. 323,315. Nov. 14, 1928.

Manufacture and production of metal carbonyls. J. Y. Johnson (I. G. Farbenindustries Akt.-Ges.). No. 323,332. Nov. 30, 1928.

Aluminium alloy. H. C. Hall and T. F. Bradbury. No. 323,353. Dec. 18, 1928.

Coating metal surfaces with rubber. F. Ahrens, and Harzer Achsen-Werke Ges., Gornum am Harz. No. 302,935. Dec. 21, 1927.

Separating-apparatus for the treatment of ores, coals and other similar materials. L. Hoyois. No. 303,810. Jan. 9, 1928.

Soldering fluxes. J. Barnett, and Associated Electrical Industries, Ltd. No. 323.392. Feb. 1, 1929.

Coated Metal rods or tubes. New Eccles Rubber Works, Ltd., and C. Hemm. No. 323,399. Feb. 7, 1929.

Casting hollow bodies. H. E. Field. No. 323,406. Feb. 16, 1929.

Electric furnaces. Heraeus Vacuumschmelze Akt.-Ges. No. 323,271. Sept. 21, 1928.

Heat-treatment of metallic products for bright annealing and analogous purposes. A. Sadler (American Mond Nickel Co.). No. 323,496. June 29, 1928.

Metal strips for use in the manufacture of metal cords and fabrics and process for manufacturing the same. L. Rado. No. 309,157. July 25, 1928.

Protection of metal surfaces against corrosion. O. Y. Imray (I. G. Farbenindustrie Akt.-Ges.). No. 323,525. Aug. 23, 1928.

Processes for obtaining precious metals. L. Mellersh-Jackson (Burg, G.). No. 323,466. Aug. 29, 1928.

Magnetic materials. Electrical Research Products, Inc. No. 313,584. June 15, 1928.

Manufacture and production of metal carbonyls. I. G. Farbenindustrie Akt.-Ges. No. 313,629. May 29, 1928.

Electrical induction furnaces. N. R. Davis and Associated Electrical Industries, Ltd. No. 323,561. Oct. 9, 1928.

Method of and apparatus for drawing wire. Gewerkschaft Wallram. No. 299,768. Oct. 31, 1927.

Manufacture of corrugated or finned tubes. F. Randle. No. 323,606. Nov. 20, 1928.

Metal-hardening furnaces. J. S. Russell and Manchester Furnaces, Ltd. No. 323,616. Dec. 1, 1928.

Chromium plating and baths therefor. Ternstedt Manufacturing Co. No. 308,771. March 29, 1928.

Manufacture of metal tubing. L. J. Bayer & Bayer Co. No. 323,640. Jan. 3, 1929.

Manufacture of aluminium silicon alloys. Soc. D'Electro-Chemie, D'electro-Metallurgie, et Des Acieres Electriques D'Ugine. No. 305,640. Feb. 8, 1928.

Bar-bending machines. G. B. Brader & B. Gabe. No. 323,673. Feb. 14, 1929.

Electrodes for use in arc-welding. Imperial Chemical Industries Ltd., and J. H. Patterson. No. 323,675. Feb. 18, 1929.

Base plate or support for alumino thermal heating cartridge. S. Percival, (Henckel Mox Corp. Ges.). No. 323,687. March 14, 1929.

(Amended Specifications Published.)

Welding. Hadley and anr. No. 190,734.

Ferrous alloys. Dawson. No. 320,332.

Canadian Patents

Subject of Invention, Patentee, Patent No. and Filing Date

Ore concentrating table. F. C. Dyer, Toronto, Ont. No. 295,669. Mar. 13, 1929.

Method of treating antimonial ores. H. Goldmann, Wilhelmsburg, Elbe, Germany. No. 295,676. Aug. 4, 1926.

Induction electric furnace. The Ajax Electrothermic Corp., Ewing Township, assignee of E. F. Northrup, Princeton, N. J. No. 295,704. Oct. 29, 1925.

High-frequency induction furnace. The Ajax Electrothermic Corp., Ewing Township, N. J., assignee of E. F. Northrup, Princeton, N. J. No. 295,705. Oct. 29, 1925.

Process of reducing ores and converting hydrocarbons. W. H. Smith, Detroit, Mich. No. 295,717. Dec. 17, 1929.

Process for the extraction of lead from sulphide ores. Fried. Krupp Grusonwerk Akt.-Ges., Magdeburg-Buckau, assignee of F. Hoppe, Magdeburg, Germany. No. 295,795. July 21, 1927.

Process of preparing radiator cores. The H. B. Smith Co., assignee of R. K. Prince, both of Westfield, Mass., administrator of the estate of C. K. Prince, Westfield, Mass. No. 295,807. Jan. 3, 1928.

Metallurgical coal. Société La Carbonisation, Société Générale d'Exploitation des Carbons, Paris, assignee of G. Jakova-Merturi, Gagny, Seine-et-Oise, France. No. 295,808. Apr. 17, 1928.

Method and apparatus for depositing metals on surfaces. T. E. Bridger, Mount Eden, Auckland, New Zealand. No. 295,842. Mar. 15, 1929.

Wrought iron with increased tensile properties. G. G. Gedda. Surahammar, Sweden. No. 295,866. Dec. 9, 1925.

Machine for bending metal sheets or plates. C. H. Sedgwick, London, England. No. 295,901. Nov. 19, 1928.

Process of recovering scrap metals. The Aluminium Limited, Toronto, Ont., assignee of the Aluminum Company of America, Pittsburgh, Pa., assignee of T. D. Stay, Cleveland, Ohio. No. 295,924. Jan. 21, 1928.

Metal recovering furnaces. The Aluminium Limited, Toronto, Ont., assignee of the Aluminum Company of America, Pittsburgh, Pa., assignee of T. D. Stay, Cleveland, Ohio. No. 295,925. Jan. 21, 1928.

Spiral finned tubing. The Bundy Tubing Co., assignee of W. W. Anderson and A. Gardner, assignee of H. W. Bundy, all of Detroit, Mich. No. 295,937. May 21, 1928.

Alloyed base for oxide coated cathodes. (Nickel-silicon). The Canadian Westinghouse Co., Ltd., Hamilton, Ont., assignee of G. W. Halleck, Bloomfield, N. J. No. 295,952. Feb. 25, 1928.

Cadmium plating. The Grasselli Chemical Co., Ltd., Hamilton, Ont., assignee of the Grasselli Chemical Co., Cleveland, Ohio, assignee of L. R. Westbrook, Cleveland Heights, Ohio. No. 295,983. Dec. 30, 1927.

Method of manufacturing galvanized nuts and bolts. H. B. Newhall, Plainfield, N. J., assignee of H. W. Pleister, Westfield, N. J. No. 296,068. May 12, 1926.

Furnace regenerator. F. R. McGee. Steubenville, Ohio. No. 296,072. Nov. 3, 1928.

Hot blast stove. F. R. McGee, Steubenville, Ohio. No. 296,073. Nov. 3, 1928.

Treatment of zinc-lead sulfide ores; mattes, etc. E. A. Ashcroft, London, England. No. 296,078. June 23, 1923.

Furnace for treating articles. H. A. Dreffein, Chicago, Ill. No. 296,090. Nov. 5, 1928.

Press for sheet metal. C. J. Rhodes, Wakefield, England. No. 296,127. May 17, 1929.

Recovery of metals and metal compounds soluble in ammoniacal liquors. I. G. Farbenindustries Frankfurt a.M., assignee of L. Schlecht and W. Schubardt, Ludwigshafen a.Rh., and F. Duftschmid, Heidelberg, Germany. No. 296,177. Mar. 30, 1928.

Built-up vertical zinc retort. The New Jersey Zinc Co., New York, N. Y., assignee of F. G. Beyer and E. H. Bunce, Palmerton, Pa. No. 296,205. July 27, 1927.

Ore and oxide reduction. H. E. Coley, London, England. No. 296,279. Aug. 25, 1928.

Protection of metallic surfaces against incrustations and corrosion. Akt.-Ges. für Chemische Industrie in Liechtenstein, Schaan, Liechtenstein., assignee of W. Thalhofer, Wien, Austria. No. 296,356. Mar. 30, 1926.

Protection of metallic surfaces against incrustations and corrosion. Akt.-Ges. für Chemische Industrie in Liechtenstein, Schaan, Liechtenstein, assignee of W. Thalhofer, Wien, Austria. No. 296,357. Mar. 30, 1926.

Aluminum casting alloy. The Canadian Westinghouse Co., Ltd., Hamilton, Ont., assignee of J. Silberstein, Niagara Falls, N. Y. No. 296,392. Oct. 14, 1926.

Electrode holder. Det Norske Aktieselskab for Elektrokemisk Industri, Oslo, Norway, assignee of H. Brock, Köln, Germany. No. 296,410. Dec. 6, 1926.

Method of treating molten magnesium and its high percentage alloys. I. G. Farbenindustrie Akt.-Ges., Frankfort a.M., assignee of A. Beck, W. Schmidt and G. Schreiber, Bitterfeld, Germany. No. 296,418. Aug. 31, 1928.

Apparatus for manufacturing pipes by centrifugal action. La Société d'Expansion Technique, assignee of R. Devillers, both of Paris, France. No. 296,472. May 2, 1928.

Apparatus for controlling electrodes in electric furnaces. Dr. Alexander Wacker Gesellschaft für Electrochemischeindustrie, München, assignee of F. X. Noichl and E. Schmidt, both of Burghausen, Oberbayern, Germany. No. 296,484. Feb. 20, 1929.

Silver-depositing composition. J. I. Bajda, South Orange, N. J. No. 296,523. Feb. 7, 1929.

Process of roasting fine ore materials. A. D. H. L. Fassottee, Overpeltlez-Neerpelt, Limbourg, Belgium. No. 296,545. Mar. 13, 1982.

Method of extracting gas from metal surfaces. I. van Boose, Böhlitz-Ehrenberg, near Leipzig, Germany. No. 296,597. Dec. 8, 1928.

Heat treatment of aluminum castings. The Bohn Aluminum and Brass Corporation, assignee of R. J. Roshirt, both of Detroit, Mich. No. 296,613. Jan. 21, 1929.

Lead welding process. The expanded Metal Co., Ltd., London, England., assignee of W. Smith, West Hartlepool, England. No. 296,666. Feb. 19, 1929.

Process of recovering volatilizable metals from ores. F. Krupp Grusonwerk Akt.-Ges., Magdeburgh-Buckau, assignee of H. Stephani, Magdeburg, Germany. No. 296,688. Apr. 8, 1927.

Pyro-metallurgical apparatus. The Phelps Dodge Corporation, New York, N. Y., assignee of C. Legrand, Douglas, Ariz. No. 296,699. Feb. 2, 1929.

Electrodes for electric furnaces. La Société Electrometallurgique de Montricher, assignee of P. L. J. Miguet, both of St. Julian de Mauriene, Savoie, France. No. 296, 712. Feb. 14, 1927.

Alloy. (*Containing Cr, Mo and U.*) R. W. Stimson, New York, N. Y., assignee of W. Borchers, Aachen, Germany. No. 296,738. Apr. 26, 1924.

Alloy. (*Fe-Cr-Mo-U.*) R. W. Stimson, New York, N. Y., assignee of W. Borchers, Aachen, Germany. No. 296,739. Apr. 26, 1924.

Process of hardening copper. H. G. Webster and J. Cameron, both of London, Ont. No. 296,755. Aug. 27, 1929.

Process of recovering various metals. F. A. Thurston, Chicago, Ill. No. 296,831. June 23, 1928.

Process of manufacturing ductile bodies of highly refractory metals. N. V. Philips' Gloeilampanfabrieken, Eindhoven, Netherlands, assignee of the Canadian Electric Co., Ltd., Toronto, Ont., assignee of J. A. van Liempt, Eindhoven, Netherlands. No. 296,845. Dec. 13, 1924.

Method of casting and rolling copper. The United States Metals Refining Co., Carteret, N. J., assignee of W. F. Eppenstein, Rahway, N. J and H. M. Green, Carteret, N. J. No. 296,937. Feb. 11, 1929.

French Patents

Subject of Invention, Patentee, Patent No. and Filing Date.

Improvements to dies and process for making these dies. Edward G. Budd Manufacturing Co. No. 676,242. June 5, 1929.

Process for separating cobalt and iron from iron-rich solutions obtained by leaching roasted pyrites. Orkla Grube Akt.-Ges. No. 676,234. June 5, 1929.

Process for the production of pulverulent lead and oxides of lead. H. Falk No. 676,244. June 5, 1929.

Process for preparing alkali and alkaline earth metals. N. V. Philips' Gloeilampenfabrieken. No. 676,248. June 5, 1929.

Process and apparatus for reducing iron ores. Trent Process Corp. No. 676,338. June 7, 1929.

Process for treating fused masses containing sulphides. Vereinigte Aluminium Werke. No. 676,340. June 7, 1929.

Continuous furnace for melting metals. G. L. Itam. No. 676,351. June 7, 1929.

Process for preparing alkali metals and halogens. Deutsche Gold und Silber Scheideanstalt vormals Roessler. No. 676,358. June 7, 1929.

Process and machine for preparing sand beds for casting pigs. R. Ardelt. No. 676,422. June 8, 1929.

Improvements in the treatment of iron and steel. R. Esnault-Pelterie. No. 676,423. June 8, 1929.

Process and apparatus for annealing and deoxidizing metals. Metallgesellschaft Akt.-Ges. No. 676,428. June 10, 1929.

Heat treatment of hardened steel. Vereinigte Stahlwerke Akt.-Ges. No. 676,474. June 10, 1929.

Improvements to processes for casting under pressure. Florence & Peillon. No. 676,708. Oct. 15, 1928.

Electric melting furnace for aluminum, zinc, tin and similar materials. E. F. Russ. No. 676,816. June 18, 1929.

Processes for decarburizing cast iron and steel. N. G. Lely. No. 676,821. June 18, 1929.

Process for preparing beryllium alloys, particularly alloys having a high beryllium content, by fusion electrolysis. Siemens & Halske Akt.-Ges. No. 676,873. June 19, 1929.

Process for roasting blendes. Société Anonyme la Nouvelle Montagne No. 676,894. June 19, 1929.

Soldering torch burning solidified alcohol or similar fuel. J. Marijon. No. 676,227. June 5, 1929.

Installation for supplying oxygen or other gases to autogenous welding or cutting stations and other apparatus. Société Les Fils de François de Wendel & Cie. No. 676,373. June 7, 1929.

Process for making hollow bodies of sheet metal. F. E. Krauss. No. 676,415. June 8, 1929.

Improvements in the fabrication of objects of tin or similar metal or alloy. Maison Devouge & Dupont. No. 676,541. June 11, 1929.

Improvements to alloys and fluxes for welding. Compagnie Francaise pour l'Exploitation des Procédés Thomson-Houston. No. 676,561. June 12, 1929.

Continuous furnace for melting copper. The American Metal Company, Ltd. No. 676,744. June 15, 1929.

Process and machine for making nut blanks. Russell, Burdsall and Ward Bolt and Nut Co. No. 676,791. June 17, 1929.

Process and apparatus for curving in the edges of metal disks. O. Wild and L. Wild. No. 676,792. June 17, 1929.

Forge blower. Société Ateliers Air et Feu (Anciens Etablissements Vivez, Société Anonyme). No. 676,856. June 19, 1929.

Process for making metal foil which is penetrable by cathode rays or X-rays or both. Rohm & Haas Akt.-Ges. No. 676,560. June 12, 1929.

Process for preparing zinc solutions used for electrolysis. L. Sturbelle. No. 676,386. June 8, 1929.

Electric furnace heated from the exterior. E. Russ. No. 676,510. June 11, 1929.

Electric arc melting furnace. Siemens & Halske Akt.-Ges. No. 676,551. June 12, 1929.

Improvements to electric furnaces. Wild Barfield Electric Furnaces Ltd., and L. W. Wild. No. 676, 763. June 15, 1929.

Improvements to induction furnaces. E. F. Northrup. No. 676,804. June 17, 1929.

Process for making shaped tool blanks of material difficult to work, such as carbides, their alloys, etc. Fried. Krupp Akt.-Ges. No. 676,350. June 7, 1929.

Process for making metallized sheets of any thickness. I. G. Farbenindustrie Akt.-Ges. No. 676,870. June 19, 1929.

Mud gun for plugging the tapping holes of blast furnaces and other furnaces. J. C. Hopkins and A. Osolin. No. 676,939. June 20, 1929.

Electrolytic process for extracting metals from their ores. L. Sturbelle. No. 677,087. June 11. 1929.

Process for hardening copper. N. O. Hedman, N. R. Naslund and J. D. Larsson. No. 677,143. June 20, 1929.

Ferrous article and process for making it. Molybdenum Corporation of America. No. 677,167. June 21, 1929.

Improvements to processes and apparatus for the electrolytic production of sheet metal. E. Kelsen. No. 677,250. June 24, 1929.

Improvements to processes and apparatus for heating, especially for melting metals. Compagnie Française pour l'Exploitation des Procedes Thomson-Houston. Addition Patent No. 35,871. (Second addition to Patent No. 604,226). Sept. 4, 1928.

Automatic conveyor, particularly for use in conveying material to be hot rolled. J. Euteneuer, A. Abrams and F. Hoffman. No. 677,117. June 18, 1929.

Improvements to welding processes. The Youngstown Sheet & Tube Co. No. 676,923. June 20, 1929.

Process and device for making homogeneous lead coatings. M. U. Schoop. No. 676,941. June 20, 1929.

Forge. J. Kopf, F. Kazda, E. Rink and E. Holub. No. 677,009. Mar. 2, 1929.

Rosin-core solder. Kester Solder Co. No. 677,103. June 15, 1929.

Process and devices for smooth-rolling and finish-rolling of tubing. Mannesmannröhren Werke. No. 677,239. June 24, 1929.

Process and machine for making seamless tubing. The Babcock and Wilcox Tube Co. No. 677,267. June 24, 1929.

Process for making metal tanks or other objects of reinforced sheet metal. Société Chaudronnerie & Tolerie de l'Est Chautodest. No. 677,484. June 27, 1929.

Improvements to powders for facilitating the separation of patterns from molds. Kelly Graphite Mills, Inc. No. 677,093. June 13,1929.

Improvements to carriages of mud guns for plugging the tapping holes of blast furnaces and other furnaces. J. C. Hopkins and A. Ososlin. No. 677,521. June 27, 1929.

Process for the reduction of metallic compounds and the production of arsenates. G. N. Kirsebom. No. 677,604. June 28, 1929.

Improvements to processes for preparing molten slag, especially slag for use in refining wrought iron. A. M. Byers Co. No. 677,606. June 28, 1929.

Improvements to processes for refining wrought iron. A. M. Byers Co. No. 677,607. June 27 1929.

Improvements to processes for refining wrought iron. A. M. Byers Co. No. 677,608. June 28, 1929.

Improvements to processes for refining wrought iron. A. M. Byers Co. No. 677,609. June 28, 1929.

Improvements to processes for refining wrought iron. A. M. Byers Co. No. 677,610. June 28, 1929.

Alloy. A. C. Spark Plug Company. No. 677,691. July 1, 1929.

Electrolytic and catalytic process for the treatment of complex ores of copper, cobalt and nickel. R. Sanz Carreras. No. 677,720. July 2, 1929.

Process for manufacturing iron and steel. R. McKnight. No. 677,875. July 4, 1929.

Improvements to magnetic alloys. Compagnie Francaise pour l'Exploitation des Procédés Thomson-Houston. No. 677,904. July 5, 1929.

Mandrel for tubing mills. P. Multhaupt. No. 677,990. July 8, 1929.

Process for the metallurgical treatment of oolitic grains extracted from minette ores, as well as other pulverulent or impalpable ores having a high iron content. P. Gredt. Addition Patent No. 35,948. (First addition to Patent No. 603,188.) Oct. 9, 1928.

Process for working liquid or plastic materials by compression and extrusion, also applicable to iron, steel and other difficultly deformable metals and alloys. P. Multhaupt. No. 677,583. June 28, 1929.

Process for coating moving metallic articles with a continuous adherent layer of another metal. British Insulated Cables, Ltd. No. 677,774. July 3, 1929.

Process for preparing a finely subdivided metallic powder obtained from a carbonyl. I. G. Farbenindustrie Akt.-Ges. No. 677,858. July 4, 1929.

Improvements in the fabrication of metallic objects. The Steel Sanitary Co. No. 677,909. July 5, 1929.

Process for making metal blanks. Société Metallurgique de Montbard-Aulnoye. No. 677,999. July 8, 1929.

Method and machine for changing the shape and improving the structure of hollow metallic objects. United States Cast Iron Pipe and Foundry Co. No. 678,028. July 8, 1929.

Rolling mill roll. Vereinigte Stahlwerke Akt.-Ges. No. 678,032. July 8, 1929.

Method of measuring the temperature of incandescent bodies. Kaiser Wilhelm Institut für Eisenforschung. No. 677,795. July 3, 1929.

Process for producing metallic carbonyls. I. G. Farbenindustrie Akt.-Ges. No. 677,548. June 28, 1929.

Mold for aluminothermic welding. J. Wattmann. No. 678,525. July 17, 1929.

Improvements to magnetic separators. H. H. Thompson, and A. E. Davies. No. 678,065. July 9, 1929.

Process for making cast iron balls for ball mills. Fried. Krupp Grusonwerk Akt.-Ges. No. 678,521. July 17, 1929.

New processes for the production and fabrication of alloys. J. M. Capdaze. No. 678,085. Oct. 20, 1928.

Method of heating iron plates or sections and furnace used in working this method. Société Anonyme d'Ougree-Marihaye. No. 678,094. Oct. 25, 1928.

New improved means for casting metals in a vacuum. J. M. R. Sinniger. No. 678,106. Oct. 26, 1928.

Device for guiding thin sheets entering rolling mills. Société Forges de Strasbourg (Société Anonyme). No. 678,268. July 10, 1929.

Improvements in the manufacture and treatment of malleable cast iron. International General Electric Co. No. 678,438, July 16, 1929.

Cooling tanks for metallurgical furnaces. Zimmermann & Jansen G.m.b.H. No. 678,475. July 16, 1929.

Process for making cast iron or steel directly from the ore, with control of the composition of the metal. Davis Steel Process Corporation. No. 678,481. July 16, 1929.

Preparation of practically homogeneous cementation materials. R. Cambier and M. Cambier. No. 678,506. July 17, 1929.

Improved aluminum alloy. Rolls-Royce Ltd. Addition Patent No. 36,023. (First addition to Patent No. 650,213.) Oct. 23, 1928.

Rolling mill for expanding tubing. Demag Akt.-Ges. No. 678,069. July 9, 1929.

Process and means for increasing the resistance of metallic structural elements to the effects of vibrations. O. Föppl. No. 678,070. July 9, 1929.

Autogenous welding process for aluminum. A. Lehelley. No. 678,136. Oct. 30, 1928.

Improvements in the manufacture of tubing. F. Sonnichsen, F. A. Frisch and H. A. Nicolaysen. No. 678,425. July 13, 1929.

Device for making holes in hollow bodies such as tubes, etc. Mannesmannröhren Werke. No. 678,426. July 13, 1929.

Improvements to metallic casings for crucibles. American Machine & Foundry Co. No. 678,460. July 16, 1929.

Improvements to metallic receptacles. Dutilleul Frères & Delcouderc. No. 678,499. July 13, 1929.

Process and device for repairing the damage plates of gas holders. Schweiss Unternehmung Wegner & Co. Kom. Ges. No. 678,549. July 17, 1929.

Photoelectric pyrometer. Société Sema. No. 678,444. July 16, 1929.

Process for the electrolytic separation of chromium for the purpose of obtaining platings of chromium on other metals. R. Appel. No. 678,157. July 20, 1927.

Method of diminishing the corrosion of iron and its alloys by sulphuric acid and acid sulphate solutions. I. G. Farbenindustrie Akt.-Ges. Addition Patent No. 35,968. (First addition to Patent No. 652,598.) Sept. 5, 1928.

Wall with refractory lining for the construction of high-temperature chambers. M. H. V. Delot. No. 678,174. June 4, 1929.

German Patents

Subject of Invention, Patentee, Patent No. and Filing Date.

Magnetic separator for the removal of magnetizable constituents from liquid streams. Fried. Krupp Grusonwerk Akt.-Ges., Magdeburg-Buckau, Germany. No. 489,173. Sept. 18, 1927.

Removable magnet pole for magnetic separators. Fried. Krupp Grusonwerk Akt.-Ges., Magdeburg-Buckau, Germany. No. 489,174. Apr. 19, 1928.

Welding burner. G. Hundertmark, Hannover, Germany. No. 489,122. Dec. 11, 1928.

Roller-bed roller with individual electric drive. Demag Akt.-Ges., Duisburg, Germany. No. 488,875. Mar. 9, 1928.

Process and apparatus for roasting and reducing ores in the rotary tubular furnace. F. L. Duffield, London, England. No. 488,950. Apr. 1, 1928.

Device for cooling smelting furnaces and the like by means of inserted cooling pipes. E. Widekind & Co., Düsseldorf, Germany. No. 488,783. Nov. 27 1925.

Heating furnace fired with powdered coal. H. Bangert, Düsseldorf, Germany. No. 488,784. Dec. 11, 1926.

Reheating furnace according to Patent 343,946 with regenerator chambers added on one side. Friedrich Siemens Akt.-Ges., Berlin, Germany. No. 488,785. (Addition to Patent No. 343,946.) June 15, 1928.

Charging device for electrode melting furnaces. Akt.-Ges., Brown, Boveri & Cie., Baden, Switzerland. No. 489,011. July 12, 1927.

Automatic electric flash welding machine. Siemens-Schuckertwerke Akt.-Ges., Berlin Siemensstadt, Germany. No. 489,012. Sept. 24, 1927.

Switching device for electric resistance welding machines. P. Schmatz, Benrath a.Rh., Germany. No. 488,812. Jan. 13, 1929.

Process for uniting radiator sections by electric resistance welding. G. R. Tellander, Göteborg, Sweden. No. 489,138. Apr. 2, 1925; in Sweden Nov. 24, 1924.

Electric welding apparatus. Electrical Research Products, Inc., New York, N. Y. No. 488,813, May 19, 1923.

Electric resistance welding machine. Westinghouse-Bremsen-Gesellschaft m.b.H., Hannover, Germany. No. 488,814. Sept. 9, 1927; in Great Britain, Oct. 11, 1926.

Process for making welding electrodes. F. Dworzak, Vienna, Austria. No. 488,815. Nov. 5, 1927; in Austria Oct. 11, 1927.

Method of working and device for use on a molding apparatus which can be moved over an elongated bed. Gewerkschaft Prudens, Siegen, Germany. No. 489,017. Mar. 17, 1928.

Cobalt alloy. Siemens & Halske, Akt.-Ges., Berlin-Siemensstadt, Germany No. 488,963. Apr. 13, 1927.

Apparatus for electrolysing solutions. Siemens & Halske, Akt.-Ges., Berlin Siemensstadt, Germany. No. 488,964. Dec. 31, 1927.

Device for removing the welding fin from the inside of butt welded pipes. K. Reincke, Eberswalde, Germany. No. 488,844. June 24, 1926.

Melting crucible for aluminothermic welding. I. Block, Berlin-Steglitz, Germany. No. 488,904. Mar. 16, 1928.

Process for aluminothermically welding a piece of small cross-section to a large surface of a heavy object. Elektro-Thermit G.m.b.H., Berlin-Tempelhof, Germany. No. 488,905. Oct. 17, 1928.

Process for welding or soldering thin sheets, sections and the like. Vereinigte Aluminium-Werke, Akt.-Ges., Lautwerk, Lausitz, Germany. No. 488,906. Mar. 31, 1928.

Head for guiding and moving a cutting burner. W. Eberle, Frankfurt a.M., Germany. No. 488,907. Aug. 2, 1927.

Process and apparatus for magnetic separation. Fried. Krupp Grusonwerk Akt.-Ges., Magdeburg-Buckau, Germany. No. 489,267. Jan. 6, 1928.

Charging device for drum-type magnetic separators. Fried. Krupp Grusonwerk Akt.-Ges., Magdeburg-Buckau, Germany. No. 489,268. May 29, 1927.

Universal rolling mill. G. Asbeck, Düsseldorf, Germany. No. 489,445. (Addition to Patent No. 456,990.) Nov. 3, 1928.

Tilting device for rolling mills. Maschinenfabrik Sack G.m.b.H., Düsseldorf-Rath, Germany. No. 489,446. Feb. 12, 1929.

Apparatus for dewatering slimes. W. Leonardy, Lötzen, Germany. No. 489,277. Feb. 27, 1924.

The utilization of iron-silicon-tin alloys obtained in the separation of iron from tin as casting alloys for the production of machinable, acid-resistant objects and process for preparing these alloys for this purpose. Th. Goldschmidt Akt.-Ges., Essen, Germany. No. 489,367. Apr. 9, 1925.

Alloy steel containing chromium, nickel and molybdenum, for rolling mill mandrels. Rheinische-Westfälische Stahl- und Walzwerke Akt.-Ges., Abt. Stahlwerk Krieger, Düsseldorf-Oberkassel, Germany. No. 489,432. Apr. 12, 1925.

Machine for turning gears placed in a quenching tank for the purpose of hardening. F. Klopp. Wald, Solingen, Germany. No. 489,368. Apr. 5, 1928.

Annealing furnace. A. Urbscheit, Berlin, Germany. No. 489,369. Aug. 26, 1928.

Electrical method for subterranean exploration. Prospector Institute für praktische Geophysik und Geologie, Dr. Hülsenbeck & Co., Frankfurt a.M., Germany. No. 489,434. Aug. 7, 1926.

Electric blast heater. Siemens-Schuckertwerke Akt.-Ges., Berlin-Siemensstadt, Germany. No. 489,379. Nov. 25, 1927.

Device for heating rolls, especially rolls of sheet mills. W. Schötteldreier, Nachrodt, Westfalen, Germany. No. 489,300. Aug. 8, 1926.

Electric resistance furnace. Allgemeine Elektricitäts Gesellschaft, Berlin, Germany. No. 489,581. Oct. 12, 1926; in the United States Oct. 10, 1925.

Device for carrying out melting operations and high-temperature chemical reactions by means of electric heating. Consortium für elektrochemische Industrie G.m.b.H., München, Germany. No. 489, 582. Apr. 18, 1924.

Electric induction furnace. J. R. de Zubiria, Bilbao, Spain. No. 489,558. Apr. 30, 1925.

Device for joining baked electrodes to the unconsumed ends of electric furnace electrodes. Siemens-Planiawerke Akt.-Ges. für Kohlefabrikate, Berlin-Lichtenberg, Germany. No. 489,475. June 27, 1926.

Method of making annular castings in a centrifugal casting mold rotating about its central axis. W. Bremicker, Barmen, Germany. No. 489,383. Mar. 21, 1928.

Centrifugal casting machine. Sand Spun Patents Corporation, New York, N. Y. No. 489,384. Aug. 14, 1928.

Apparatus for casting bars of aluminum and similar metals. J. Züblin, Singen, Hohentwiel, Germany. No. 489,385. Jan. 18, 1927; in Switzerland, Oct. 13, 1926.

Roasting gas circulation in roasting furnaces for zinc blende and other sulphidic ores. Balz-Erzröstung G. m. b. H., Gleiwitz, Germany. No. 489,485. Sept. 6, 1928.

Packing for drums, such as rotary tubular furnaces, rotating in a stationary housing. Fried. Krupp Grusonwerk Akt.-Ges., Magdburg-Buckau, Germany. No. 489,486. (Addition to Patent No. 464,675.) May. 21, 1927.

Device for regulating the flow from settling machines. Fried. Krupp Grusonwerk Akt.-Ges., Magdeburg-Buckau, Germany. No. 489,714. May 28, 1927.

Device for cooling blast furnace throats. Buderus'sche Eisenwerke u.M. Zillgen, Wetzlar, Germany. No. 489,854. Oct. 19, 1927.

Self-baking continuous electrode with a cross-section of oval or elongated shape. Det Norske Aktieselskab for Elektrokemisk Industri, Oslo, Norway. No. 489,752. Apr. 25, 1928; in Norway Apr. 21, 1927.

Device for lifting molding flasks. C. Adey, Solingen, Germany. No. 489,827. Oct. 2, 1927.

Process and machine for making hollow metallic bodies by centrifugal casting. Sand Spun Patents Corporation, New York, N.Y. No. 489,866. Jan. 26, 1927.

Apparatus for the electrolytic refining of aluminum. Compagnie des Produits Chimiques et Electrométallurgiques Alais, Froges et Camargue, Paris, France. No. 489,869. Apr. 26, 1928; in France July 4, 1927.

Aluminum alloy with high silicon content, improved according to Patent 417,773. Metallgesellschaft Akt.-Ges., Frankfurt a.M., Germany. No. 489,828. (Addition to Patent No. 417,773.) Apr. 30, 1921.

Method of determining the resistance to rusting of iron, steel and ferrous alloys. C. Mauler, Vienna, Austria. No. 489,881. July 15, 1927; in Austria July 22, 1926.

Method of operating several constant-pressure welding burners from common oxygen and acetyline supply lines. F. Mangiameli, Düsseldorf, Germany. No. 489,788. Feb. 24, 1929.

Welding flux for aluminum. W. Doerbecker, Sande, near Hamburg, Germany. No. 489,641. July 7, 1927.

Adjusting device for cutting and welding burners. Akt.-Ges. für Tiefbohrtechnik u. Maschinenbau vormals Trauzl & Co., and F. Müller, Vienna, Austria. No. 489,789. Aug. 2, 1928; in Austria July 20, 1928.

Apparatus for the magnetic separation of material of different grain sizes. Fried. Krupp Grusonwerk Akt.-Ges., Magdeburg-Buckau, Germany. No. 490,268. (Addition to Patent No. 439,003.) Mar. 5, 1926.

Roll, especially a grooved roll, for rolling mills. R. Sperling and A. Otto, Bochum-Weitmar, Germany. No. 490,185. Dec. 15, 1928.

Process for making nails, especially horse-shoe nails, from an endless wire, using a four-jawed press. O. Mustad & Sön, Oslo, Norway. No. 490,354. May 31, 1928.

Process for the production of metallic carbonyls. I. G. Farbenindustrie Akt.-Ges., Frankfurt a.M., Germany. No. 490,415. May 5, 1927.

Process for reducing metallic oxides, especially iron ores in closed, vertical chambers surrounded by heating flues. W. H. Smith, Detroit, Mich. No. 490,409. Oct. 1, 1926; in the United States Feb. 17, 1926.

Process for the production of titanium-iron alloys which are utilizable in the molten condition. W. Mathesius and H. Mathesius, Berlin-Charlottenburg, Germany. No. 490,490. Dec. 18, 1925.

The utilization of known chromium and chrome-nickel steels as the material preventing the catalytic decomposition of the nitrogenizing gas in the construction of nitrogenizing hardening furnaces. Fried. Krupp Akt.-Ges., Essen, Ruhr, Germany. No. 490,017. Sept. 5, 1925.

Inclined drum for rotary tubular furnaces, for example cementation furnaces, with helical ribs on its inner wall for moving the material forward. H. Schaffert, Halle a.d.S., Germany. No. 490,359. Feb. 16, 1927.

Apparatus for the continuous electrical annealing of wire or strip made of metals or alloys, in which molten metallic baths are used in the heating circuit for liquid contacts. S. Junghans, Viilingen, Baden, Germany. No. 490,282. Oct. 31, 1928.

Process for graphitizing white or mottled pig iron by annealing. D. Saito, and H. Sawamura, Kyoto, Japan. No. 490,191. Apr. 22, 1927; in Japan July 17, 1926.

Electric annealing furnace and method of operating the same. Siemens-Schuckertwerke Akt.-Ges., Berlin-Siemensstadt, Germany. No. 490,423. July 17, 1927; in Austria Mar. 18, 1927

Furnace for annealing pipes, in which the pipes are moved in and out of the furnace by means of vertically displaceable conveyer roller beds. Schloemann Akt.-Ges., Düsseldorf, Germany. No. 490,192. Nov. 22, 1927.

Electric annealing furnace with removable jacket or heat-insulating hood. W. Tirre, Bremen, Germany. No. 490,639. Dec. 16, 1924.

Heating furnace with preheating chamber for heating rivets or other small iron objects of different sizes. O. Schmidt, Dortmund, Germany. No. 490,424. May 20, 1928.

Arc resistance furnace. Akt.-Ges. Brown, Boveri & Cie., Baden Switzerland. No. 490,025. June 4, 1927.

Process for making a crucible for electric high-frequency furnaces. Allgemeine Elektricitäts Gesellschaft, Berlin, Germany. No. 490,597. Nov. 4, 1927; in the United States Nov. 3, 1926.

Jar molding machine. W. Lewis, Haverford, Pa. No. 490,542. Apr. 23. 1926; in the United States Sept. 26, 1925.

Process for purifying aluminum and aluminum alloys by reduction of pressure on the molten metal. A. Godefroid, Berlin, Germany. No. 490,349. Apr. 17, 1926.

Process for making bars for rolling and pressing, having high crystallization velocity, out of non-ferrous metals. Erftwerk Akt.-Ges., Grevenbroich, Niederrhein, Germany. No. 490,350. Sept. 27, 1927.

Process for producing an aluminum or aluminum alloy coating on iron objects. Hartstoff-Metall Akt.-Ges. (Hametag), Berlin-Cöpenick, Germany. No. 490,351. Dec. 1, 1925.

Molten metal reservoir for use in die-casting aluminum alloys, into which the solid casting metal is introduced in the form of a piston. Siemens & Halske Akt. Ges., Berlin-Siemensstadt, Germany. No. 490,484. July 6, 1926.

Emptying device for molding flasks suspended from an overhead track. The Grabler Manufacturing Company, Cleveland, Ohio. No. 489,966. Sept. 17, 1926; in the United States Sept. 19, 1925.

Desulphurization and enrichment of sulphidic iron ores. W. S. Millar, London, England. No. 490,125. May 20, 1925.

Mechanical roasting furnace, especially for roasting zinc blende. R. von Zelewski, Hennef a.d.Sieg, Germany. No. 490,126. July 5, 1928.

Extraction of lead from complex lead sulphide ores and concentrates. S. C. Smith, London, England. No. 490,304 July 1, 1926; in Great Britain July 21, 1925.

Plant for obtaining the materials contained in sea water. B. Cernik, Pribram, Czechoslovakia. No. 490,207. June 29, 1926; in Switzerland, May 8, 1926.

Production of nickel or nickel-copper alloys. The International Nickel Company, Inc., New York, N. Y. No. 490,092. Nov. 29, 1924.

Production of objects out of metals having a high melting point. N. V. Philips' Gloeilampenfabrieken Eindhoven, Netherlands. No. 490,439. (Addition to Patent No. 407,951.) Dec. 28, 1927; in the Netherlands Feb. 7, 1927.

Copper-silicon-zinc alloy. Wilhelm Zimmer G.m.b.H., Giessen, Germany. No. 490,305. Nov. 13, 1927.

Furnace for heat treating light metals. R. Gautschi, Singen, Hohentwiel and H. Wulff, Bonn, Germany. No. 489,970. Nov. 3, 1927.

Device for cleaning implements made of noble metals by contact action in alkaline lyes. Carl Mann & Co., G.m.b.H., München, Germany. No. 490,617. Oct. 7, 1927.

Process for obtaining great adherence between light-metal printing rollers and the metal electrodeposited thereon. Schnellpressenfabrik Koenig & Bauer Akt.-Ges., Würzburg, Germany. No. 490,546. Nov. 13, 1926.

Process for obtaining electrolytic metallic deposits of different thicknesses. F. Eichleiter, Vienna, Austria. No. 490,618. May 2, 1926; in Austria, Apr. 26, 1926.

Cleaning device for pipe-galvanizing plants. A. Dominikowski, Mülheim a.d.Ruhr-Styrum, Germany. No. 490,135. June 21, 1927.

Process for producing coatings on light metals. Dr. Otto Sprenger, Patentverwertung Jirotka m. b. H., Vaduz, Liechtenstein. No. 489,974. (Addition to Patent No. 488,554.) Oct. 8, 1927.

Apparatus for classifying slimes. T. G. Martyn, Johannesburg, Transvaal, South Africa. No. 490,973. Apr. 16, 1926.

Dewatering apparatus, especially for coal and the like. Woodall-Duckham (1920) Limited and R. Krall, London, England. No. 490,974. Sept. 22, 1925; in Great Britain Aug. 28, 1925.

Process for working up floatable materials, such as ores, coal, graphite and the like. W. Schäfer and Erz u. Kohle-Flotation G.m.b.H., Bochum, Germany. No. 490,875. May 5, 1927.

Process and device for hardening the bearing surfaces of driving shafts and the like. F. Klopp, Wald, Rheinland, Germany. No. 490,894. Feb. 15, 1929.

Pasty, brushable coating for preventing diffusion of carbon in case-hardening. L. Plaichinger, München, Germany. No. 490,895. Jan. 6, 1927.

Process for annealing thin, flat objects in the furnace. E. Bohler, Rosselange, Moselle, France. No. 490,770. (Addition to Patent No. 379,218.) June 19, 1927; in France June 19, 1926.

Method of determining the magnitude and direction of the magnetic vector of artificially produced earth currents in geophysical investigations in which alternating currents are used. Prospector Institut für praktische Geophysik und Geologie, Dr. Hülsenbeck & Co., Frankfurt a.M., Germany. No. 490,910. July 28, 1925.

Process for developing high permeability under low magnetizing fields in alloys used for magnetic purposes containing iron and nickel, especially those containing 87.5% nickel. Electrical Research Products Inc., New York, N. Y. No. 490,911. Oct. 9, 1921.

Process for obtaining constant as possible permeability over a wide range of low flux densities in an alloy used for magnetic purposes and containing nickel and iron, the nickel content being over 30%. Electrical Research Products Inc., New York, N. Y. No. 490,912. July 31, 1925.

Process for making tubular heating elements built up of two concentric metal tubes. T. Stiebel, Berlin, Germany. No. 490,781. Jan. 19, 1928.

Apparatus for butt-welding split tubing. R. Kronenberg, Post Immigrath, Germany. No. 490,914. June 24, 1927.

Arc welding transformer having voltage drop regulation. E. Schröder, Berlin, Germany. No. 490,915. Dec. 16, 1925.

Norwegian Patents

Subject of Invention, Patentee, Patent No. and Filing Date.

Electric reduction furnace. J. Hole, Oslo, Norway. No. 47,081. May 10, 1928.

Process for the production of smooth and coherent electrolytic deposits of metal. Metallgesellschaft Akt.-Ges., Frankfurt a.M., Germany. No. 47,085. Oct. 18, 1928.

Apparatus for cleaning metallic objects. E. Harbeck, Partille, Sweden. No. 47,095. Nov. 29, 1927.

Process for extracting metals, such as zinc and vanadium with the aid of acids. The Rhodesia Broken Hill Development Co., Ltd., Broken Hill, North Rhodesia, South Africa. No. 47,232. Dec. 15, 1926.

Process for the precipitation of solutions containing vanadium. The Rhodesia Broken Hill Development Co., Ltd., Broken Hill, North Rhodesia, South Africa. No. 47,233. Dec. 15, 1926.

Process for removing silica from metal-bearing solutions. The Rhodesia Broken Hill Development Co., Ltd., Broken Hill, North Rhodesia, South Africa. No. 47,234. Dec. 15, 1926.

Process for extracting vanadium from solutions. The Rhodesia Broken Hill Development Co., Ltd., Broken Hill, North Rhodesia, South Africa. No. 47,325. Dec. 15, 1926.

Process for extracting vanadium. The Rhodesia Broken Hill Development Co., Ltd., Broken Hill, Rhodesia, South Africa. No. 47,236. Dec. 15, 1926

Process for coating a body with platinum. N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands. No. 47,250. Aug. 20, 1927.

Welding method and welding composition for the same. B. Racheef and M. Gofmann, Paris, France. No. 47,254. June 13, 1927.

Process for coating with metal. American Machine and Foundry Co., New York, N. Y. No. 47,298. Dec. 10, 1926.

Swedish Patents

Subject of Invention, Patentee, Patent No. and Filing Date.

Method of operating electric bright-annealing furnaces and device used with the same. Siemens-Schuckertwerke G. m. b. H., Berlin-Siemensstadt, Germany. No. 68,747. Nov. 27, 1926; abroad Dec. 3, 5, 10 and 12 ,1925.

Electrode seal for electric furnaces. Siemens & Halske Akt.-Ges., Berlin-Siemensstadt, Germany. No. 68,782. May 19, 1926; abroad May 20, 1925.

Process for the tough-annealing of alloys. J. L. la Cour and F. O. M. Lindh, Helsingborg, Sweden. No. 68,788. Nov. 13, 1924.

Swiss Patents

Subject of Invention, Patentee, Patent No. and Filing Date.

Process for removing gases from and cleaning the surfaces of metallic objects. J. von Bosse, Leipzig, Germany. No. 134,959. Oct. 24, 1928.

Process for making a bearing metal of the ternary system copper–antimony–lead. S. Deiches, Wien, Austria. No. 134,993. June 18, 1928; in Austria June 24, 1927.

Process for improving copper-free aluminum alloys. Aluminium Industrie Akt.-Ges., Neuhausen, Switzerland. No. 134,994. Sept. 22, 1928.

Process for the electrolytic production of magnesium. Aluminium Industrie Akt.-Ges., Neuhausen, Switzerland. No. 134,995. Nov. 23, 1927.

Process for producing aluminum by fusion electrolysis. Vereinigte Aluminium Werke Akt.-Ges., Lautawerk, Lausitz, Germany. No. 134,996. Oct. 2, 1928; in Germany Sept. 3, 1928.

Chill mold for casting non-ferrous metals. A. M. Erichsen, Berlin-Steglitz, Germany. No. 134,997. Oct. 17, 1928; in Germany Nov. 2, 1927.

Coating for arc welding electrodes. La Soudure Autogène Soc. An., Brussels, Belgium. No. 134,998. July 16, 1928; in France Mar. 12, 1928.

Process for making a magnetic material. N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands. No. 135,263. June 25, 1928; in the Netherlands July 19, 1927.

Process for the production of aluminum and aluminum alloys. Aluminium Industrie Akt.-Ges., Neuhausen, Switzerland. No. 135,264. Nov. 1, 1928.

Process for the electrolytic production of pure aluminum from crude aluminum, aluminum alloys and the like. Aluminium Industrie Akt.-Ges., Neuhausen, Switzerland. No. 135,265. Oct. 11, 1928; in Germany, Feb. 4, 1928.

Metal die-casting mold with device for diminishing the pressure of the stream of molten metal. S. Junghans, Villingen, Baden, Germany. No. 135,266. July 16, 1928; in Germany Dec. 20, 1927.

Process for making foundry molds for casting easily oxidizable metals. Le Magnesium Industriel, Paris, France and British Maxium Ltd., London, England. No. 135,525. Mar. 12, 1928; in France July 5, 1927.

Process and mold for casting compound ingots. Aluminium Limited, Toronto, Ont. No. 135,526. Dec. 10, 1928; in the United States Jan. 27, 1928.

Process for pickling metals. Gesellschaft für Chemische Industrie in Basel, Basel, Switzerland. No. 135,756. Mar. 10, 1928.

Process for producing metallic iron with simultaneous cracking of heavy hydrocarbons. Società Italiana per le Industrie Minerarie e Chimiche, Genoa, Italy. No. 135,794. Apr. 13, 1928.

Process for improving metals of the iron and steel type, which are to come into contact with liquefied gases of low boiling point. Gesellschaft für Industriegasverwertung m. b. H., Berlin-Britz, Germany. No. 135,800. Sept. 14, 1928; in Germany Sept. 28, 1927.

Pittsburgh Metallurgist Honored

Recognizing his development of a new process for the mass production of wrought iron as an outstanding contribution to the advancement of metallurgy, the American Institute of Mining and Metallurgical Engineers at the annual convention of the organization in New York conferred the Robert W. Hunt Medal upon Dr. James Aston, of Pittsburgh, consulting metallurgist of the A. M. Byers Company and director of Mining & Metallurgy at Carnegie Institute of Technology.

This most prized award of the iron and steel industry has been given by the Institute only three times in the last ten years. It was awarded to Dr. Aston for his paper, "A New Development in Wrought Iron Manufacture"—a practical description of the process which promises to revolutionize the manufacture of this oldest of all base metals—wrought iron.

Reviews of Manufacturers' Literature

In this department we shall list each month a selection of the catalogs, books, treatises and other printed matter issued by manufacturers which, in our judgment should be of interest to the readers of Metals & Alloys. *Unless otherwise noted, any of the items listed may be secured free upon application to the issuing firm. Manufacturers who have not yet sent in their printed matter for consideration by the editor of this department are invited to do so, and it is suggested that* Metals & Alloys *be placed on the regular mailing list so that advance copies of any material of interest to the metallurgical field may automatically come to this department*—Editor.

Gold and Silver Solders.—A handy 24-page pocket size booklet giving useful information concerning gold and silver solders. Also complete soldering instructions and some metallurgical data compiled by E. A. Capillon, Metallurgical Engineer, Makepeace Company, Attleboro, Mass.

Bearing Metal.—Bulletin No. 10. A 12-page pamphlet describing the properties and applications of Parsons' White Brass S.A. A bearing metal specially prepared for marine engines, diesel motors and turbines. Contains microphotographs and detailed information as to physical and mechanical properties. Cramp Brass and Iron Foundries Company, Philadelphia, Pa.

Amsler Tensile Testing Machines.—Bulletin No. 34. A 24-page pamphlet outlining the advantages of design and construction of the Amsler Tensile Testing Machines with some remarks on checking the calibration of testing machines over their entire range. Various types of Amsler Tensile Testing Machines are illustrated and described. There is a chapter explaining in detail the construction and operation of the Amsler pendulum dynamometer which is the characteristic feature of the Amsler hydraulic testing machinery. Herman A. Holz, 167 East 33rd Street, New York, N. Y.

Arc-Welding Manual.—The fourth edition of the General Electric Arc-Welding Manual is an attractive 208-page book handsomely bound in flexible leather cover and giving a wealth of information on arc-welding. It is copiously illustrated, contains many useful tables and is provided with an index. There is a great deal of new material not contained in previous editions of this manual especially on some subjects such as the training of operators, automatic arc-welding and atomic hydrogen arc-welding and arc-welding in steel construction. (This publication will be reviewed in detail in our section devoted to Book Reviews.) General Electric Co., Schenectady, N. Y.

Amsco Bulletin—The January issue of this interesting trade publication starts the second year and gives useful information as to various industrial applications of Amsco manganese steel and Fahralloy heat and corrosion resisting alloy. American Manganese Steel Company, Chicago Heights, Ill.

Electroplating Equipment—A 12-page bulletin gives detailed information as to the construction and operation of the U. S. Self-emptying Plating Barrel for nickel, brass, copper, lead and tin plating and for electro-galvanizing small sized articles. Illustrated. U. S. Galvanizing and Plating Equipment Corporation, 32 Stockton Street, Brooklyn, N. Y.

Catalog No. 1092.—This treatise covering 8 pages, devotes 4 pages to photomicrographs. Each of the photomicrographs has its specific data indicated showing the manner in which the grinding, polishing and etching has taken place. This publication should prove extremely interesting since it is a concise and carefully planned record of the steps to be taken in preparing samples for photomicrography. E. Leitz, Inc., 60 E. 10th St., New York.

Illium.—A recent leaflet on Illium, a complex alloy based on the nickel-copper-chromium ternary system, gives the physical characteristics of Illium, "G," also the results of corrosion tests. Burgess-Parr Company, Moline, Illinois.

High Temperature Cement.—Hytempite, a refractory cement for boiler settings, metallurgical furnaces and other industrial furnaces, is discussed in a recent 8-page bulletin. Methods of applying the product, both in new construction and in making repairs, are mentioned. Quigley Furnace Specialties Co., 26 Cortland St., New York, N. Y.

Plating Equipment.—A new catalog, 128 pages, with index, goes very thoroughly into the subject of electroplating equipment, including polishing and buffing supplies for the operations preceding the plating. Formulas for electroplating baths and other useful information are included Hanson-VanWinkle-Munning Co., Matawan, N. J.

Corrosion-Resistant Paint.—A small leaflet describes Densol coatings for protecting metals and other surfaces against corrosion by the atmosphere and by fumes. Densol Specialty Paint Mfg. Co., 43 Rockside Road, Independence, Ohio.

Electric Heat in Industry.—Is the title of a new bulletin giving conderable interesting and useful information on industrial applications of electric heat. Applications in a number of chemical engineering processes are mentioned. General Electric Co., 1 River Road, Room 311, Building 6, Schenectady, N. Y.

Laboratory Furniture.—A new 72-page catalog gives information and illustrations on a complete line of laboratory furniture made of copper-molybdenum corrosion-resisting alloys. A number of new developments in the line of laboratory furniture are included. Alloy Laboratory Equipment Co., Inc., 41 E. 42nd Street, New York, N. Y.

Wire Cloth.—A new 4-page bulletin discusses wire cloth in a variety of weaves, meshes, widths and metals. It also mentions an unusually fine weave of 400 mesh, which is thought to be the smallest available. This mesh contains 160,000 openings per square inch. Newark Wire Cloth Co., Newark, N. J.

Wrought Iron.—"Comparative Properties of Wrought Iron" is the title of an article approved by the director of the Bureau of Standards, giving reports on government tests comparing different grades of wrought iron. The article is available in reprint form. A. M. Byers Co., Pittsburgh, Pa.

The Plating of Rolled Zinc and Zinc Base Die Castings.—A 12-page illustrated bulletin assembling, in as complete and concise form as possible, the information necessary for the practical plating of rolled zinc and die cast zinc parts. The New Jersey Zinc Co., 160 Front St., New York.